April 1971

Smithsonian

Ali Javan and his 40 lasers (page 42);
he is shown with two of them

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Smithsonian is published monthly by the Smithsonian Associates, 900 Jefferson Drive, Washington, D.C. 20560.
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Subscription price $10 a year in U.S. and possessions, $11.50 elsewhere.
Single copy price $1.00
Second class postage paid at Washington, D.C.
Editorial offices at Arts and Industries Building, 900 Jefferson Drive, Washington, D.C. 20560.
Advertising and circulation offices at 420 Lexington Ave., New York, New York 10017.
Please address all subscription correspondence and change of address information to P.O. Box 404, Flushing, New York, 11378.

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Smithsonian

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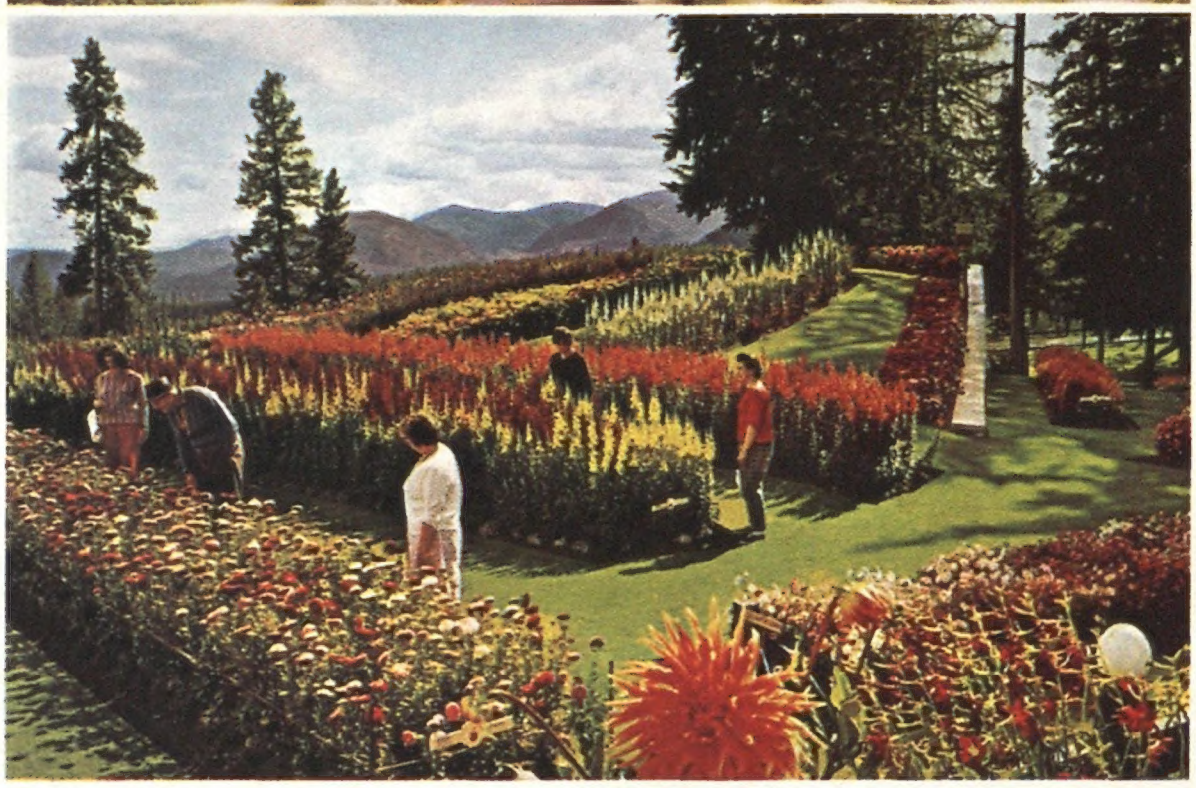

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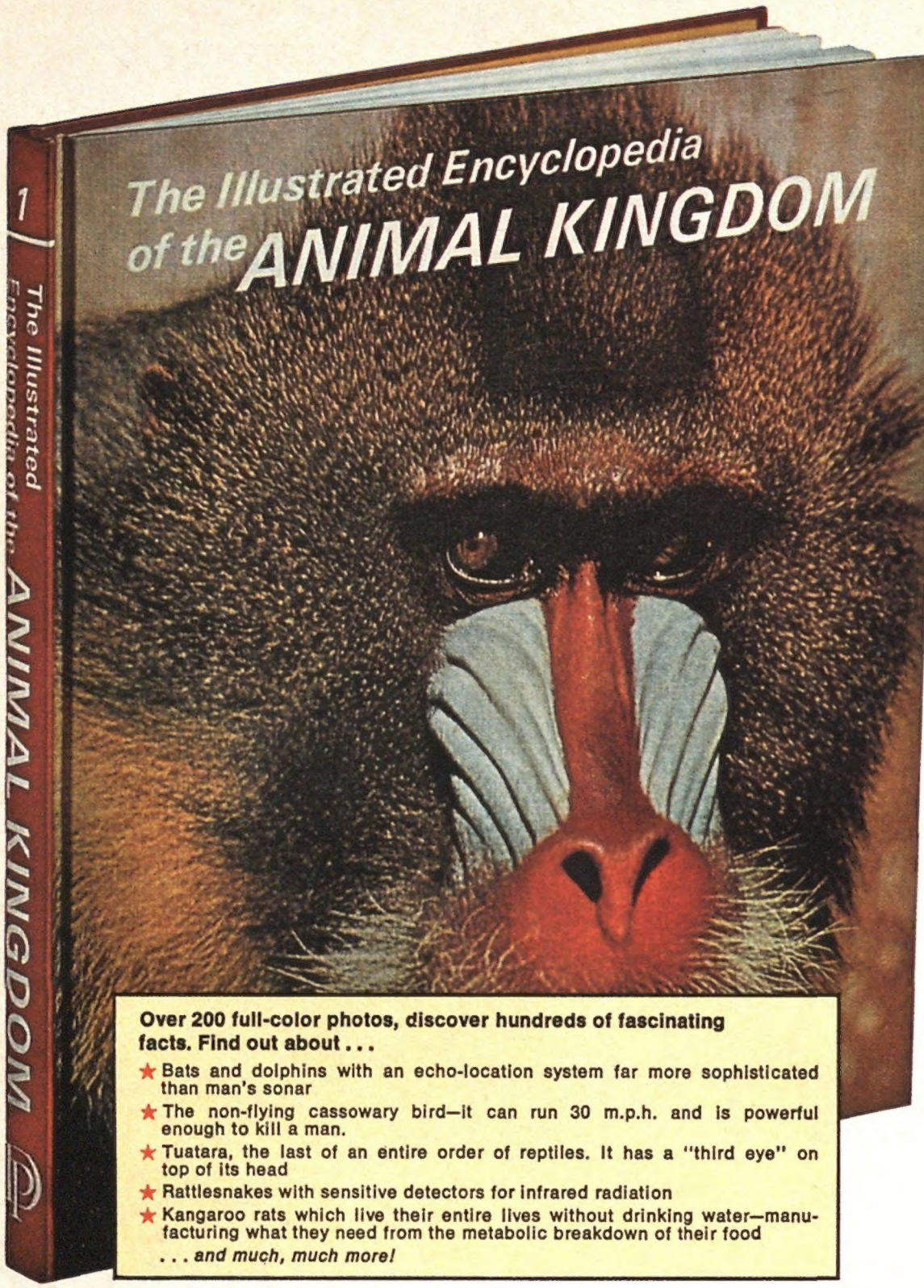

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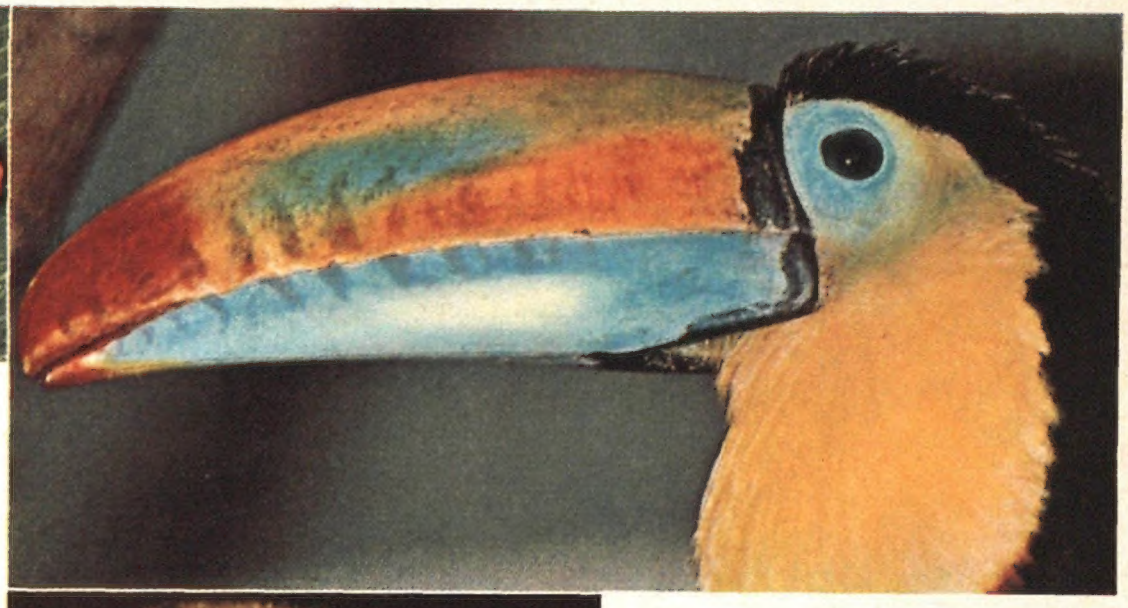

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Secretary Ripley's comments

The view from the castle

A backward glance at SMITHSONIAN *and a look ahead at further plans for 'increase & diffusion of Knowledge'*

This issue marks the anniversary of the appearance of the new vehicle for our National Associates, the magazine SMITHSONIAN, one year old this month. It is a lusty baby, as indicated by our membership of some 230,000 Associates from all 50 states of the union. We hope that in this, the Smithsonian Institution's 125th year, the creation of the National Associates will serve to spread abroad the essential message of the Institution, the "increase & diffusion of Knowledge"—to which one might add "the increase and diffusion of Interest."

How many of us feel life is humdrum, full of repetition and sameness? But life has far more to offer especially in the never-ending pursuit of knowledge which comes with a quickened interest and an alert mind. As Joseph Henry quoted James Smithson, "Knowledge should not be viewed as existing in isolated parts, but as a whole. Every portion throws light on all the others."

In Washington the Institution continues at a vigorous pace, striving to perfect our public exhibits on the one hand, while constantly struggling to secure additional support for the research activities of our professional staff. We are encouraged this year by an awakened national interest in the building of the long-planned National Air and Space Museum, which, if opened by 1976, could thrill the hearts of many millions of Americans in that year. A new Director for the Museum, former astronaut Michael Collins, will have charge of the realization of this national goal.

In the August issue Robert Evett wrote about the 4,000 musical instruments in our collections and our long effort to take them out of cabinets and give "their voices back" through patient research and restoration. This month we open our new Hall of Music in the Museum of History and Technology. The heart of this Hall will be playable instruments and musicians to play them, in daily demonstration concerts.

Last October's article on the Project Tektite aquanauts and the one in November on radio astronomy gave a hint of Smithsonian research programs which will soon take a forward leap, thanks to exciting technological contributions.

More recently, in the March issue, Meryle Secrest reported on the Smithsonian's rediscovery of Romaine Brooks, an "American in Paris" whose paintings have been long overlooked. The current Romaine Brooks exhibit at our National Collection of Fine Arts restores her to her proper place in American art history.

In this issue we announce the *Johnson-Sea-Link,* a highly sophisticated diving craft that will serve underwater field research needs, from submarine archaeology to marine biology. The genetic history of our white tigers, also in this issue, reflects the dual mission of our National Zoological Park. Even as we forge a major construction program for the zoo's public facilities, we are seeking to strengthen its research programs in conservation of endangered species, genetic quality and animal behavior.

These few examples lead us to believe that SMITHSONIAN is indeed a mirror of the Institution's many faces and interests. My thanks again for your support as Associates. The Institution needs positive and interested members to help us promote research, encourage scholarship and express all this by spreading knowledge through publication and exhibits.

S. Dillon Ripley

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Letters to the Editor

Welfare Island

Dear Sir: Although your article on Welfare Island in the February issue depicted a place of sadness and misery, pleasant memories returned to me. For many, the Island was a home and, to many of us, a home away from home.

One cannot forget the trolley, which had as its sole purpose a stop at the Island, clanging its way across the 59th Street Bridge. It didn't run when the snow or rain was too heavy. We had the shortest ferry ride in the city, or anywhere else probably, to East 78th Street.

Christmas brought caroling to the patients; spring, intense but friendly rivalry among the hospitals' softball teams.

History would not justify leaving out City Hospital, located on the southern tip, or the octagonal rotunda of the lunatic asylum becoming the rotunda of Metropolitan General Hospital (where I started my career many years ago).

There can only be peace and joy for those fortunate enough to live in the new dwellings planned for the little bit of countryside inside the city of New York.
Alfred B. Miller jr.
New York, New York

Animal eyes

Dear Sir: I am an ophthalmologist and my hobby is comparative ophthalmology. I cannot help but admire the beautiful pictures taken by Mrs. Constance Warner of animal eyes in your February issue.
Rudolf F. Binder, M.D.
Chardon, Ohio

Charles Richter

Dear Sir: This is not to make light of the California earthquake, but I thought how appropriate that I should receive your February issue on that very day with the excellent article by Kate Holliday about Charles Richter, the "earthquake man."
James E. Keefer
Salem, Oregon

Dear Sir: Your February issue was, as expected, fascinating, particularly the article about Charles Richter whose name is now so much a part of the language.

Kate Holliday, the author, seems to find it somewhat surprising that Dr. Richter is a *Star Trek* fan. I would be surprised if he were not, since he so obviously is a man of discrimination and intelligence in his dedication to the pursuit of knowledge—qualities seemingly more prevalent in *Star Trek's* time than in our own. A few more individuals like Dr. Richter and the commander of the starship *Enterprise,* concentrated in our present, might help insure survival into *Star Trek's* future.
Kristina Trott
Andover, Massachusetts

Plight of eagles

Dear Sir: I must take issue with the letter of Dr. Paul D. Harwood, in your February Letters to the Editor, both as to the numbers of breeding pairs of bald eagles along the south shore of Lake Erie and as to their reproductive success.

Dr. Harwood implies that, because he saw one eaglet when he approached an eagle's nest in Ohio, bald eagles are not suffering from DDT poisoning. The bald eagle nesting survey by Laurel Van Camp of the Ohio Department of Natural Resources found only six active nests, all in Sandusky and Ottawa counties. Only one young bird, presumably the bird seen by Dr. Harwood, was raised in 1970 and only two were raised in 1969. This rate of reproduction is not nearly enough to insure the survival of the bald eagle as a nesting bird in Ohio.
Joseph P. Kleiman, Ph.D.
Birmingham, Michigan
The U.S. Game Management agent who conducts the surveys each spring confirms the figures Dr. Kleiman cites. There were six active nests found in Ohio in 1970 and one eaglet, there were seven active nests and two young in 1969, and seven active nests and three young in 1968. Their numbers are diminishing. Ed.

Lake Erie fish

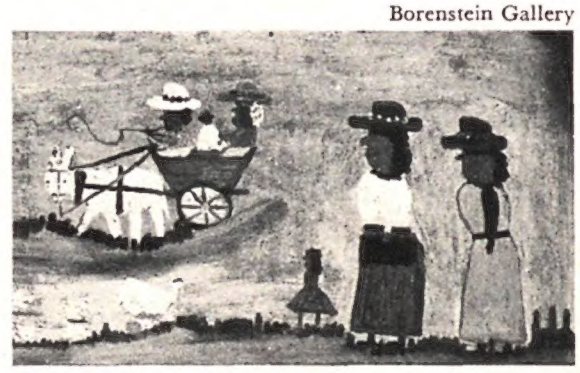
Dear Sir: Robert H. Bridges' letter in the February issue attributed this statement to Dr. William T. Pecora, director of the U.S. Geological Survey: "The fish harvest of Lake Erie [is] equal to the rest of the Great Lakes combined." Whether true or not, it is irrelevant. What is noteworthy is that the most valuable Lake Erie species—both commercially and from a sportsman's standpoint—have declined tragically or become extinct. Since 1956, the catch of high-priced species like sturgeon, whitefish and blue pike has fallen from 30 million pounds to less than a million. Meanwhile, trash fish, which do better in a more eutrophic lake, are rapidly proliferating. There are other factors besides the ecological rape of the lake involved, but that is a prime cause.
John M. Hanchette
Niagara Falls, New York

Folk artists

Dear Sir: Your article, "Painted memories: folk artists are back on the scene" and the accompanying illustrations were particularly interesting to people in Louisiana. However, there's no doubt you'll be hearing from some Louisianians because our own Clementine Hunter of Melrose Plantation fame was not mentioned.

Quite old now, en route to 90, she still lives in the area where Melrose once furnished the bulk of her "out of her head" inspirations. Anyone who owns a painting by Louisiana's black Grandma Moses values it highly as truly representative of primitive art at its best.
Mrs. Loree Oursler
Shreveport, Louisiana
See below. Ed.

Borenstein Gallery



The detail (above) is from a Melrose Plantation panel by Clementine Hunter.
Continued on page 11

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Continued from page 8

Dear Sir: Some of your readers might like to know that the Grand Pa Wiener exhibition organized by the New York State Historical Association and described in your February issue may be seen at the Museum of American Folk Art in New York City through April 18.

Recurrent interest in folk art as a contemporary expression is amply attested to by response to our own recent exhibition of 20th-century Folk Art, which included most of the works reproduced in Mr. Frankenstein's article. It is also attracting new serious scholarly attention, as in the case of Joanne Bock's excellent graduate thesis on Grand Pa Wiener.

M. J. Gladstone, Director
Museum of American Folk Art

Lemmings

Dear Sir: John B. Calhoun's "The lemmings' periodic journeys are not unique," in your January issue, is one of the most provocative articles that I have ever read. Let me reemphasize that it seems to me the author is telling us that the citizens of the United States are rapidly becoming lemmings.

We are more and more willing to accept things being done for us and losing our own personal initiative and responsibility, and are ready to follow the Pied Piper. As one caption says about Calhoun's mice, "They have never learned normal adult ways, so they follow his feet with the thoughtless curiosity of babies." This is happening in our country today. Too many of our social programs are shortchanging our people by taking from them the necessity to develop personal initiative and solutions.

E. G. Chuinard, M.D.
Portland, Oregon

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By Samuel Eliot Morison

Cabot, the mysterious sailor who gave England rights to North America

His name meant 'Coaster,' and he lived up to it when he dared fog and ice to probe Newfoundland's unknown waters

In the spring of 1497, only five years after Columbus' first voyage, John Cabot set out from England to seek a high-latitude route to the Indies. In view of his importance as the first discoverer of North America since the Northmen's voyages almost five centuries earlier, and as the man who gave England her claim to America, it is amazing how little we know about John Cabot. But not for lack of trying. During the last century and a half, research into his life and voyages has been both intense and assiduous, and the results have been disappointingly meager.

No portrait or personal description of him, no letter, no scrap of his handwriting, not even a signature, have been found. His momentous first voyage cannot be definitely traced. We have no sea journal by Cabot himself as we have from Columbus, nor did any of his shipmates leave an account of the voyage. Most of the evidence about the voyages is hearsay, some from his contemporaries in England, who may have interviewed members of the crew, and from people who made wild guesses. It is no wonder that scholars disagree about Cabot. One has to discard part of the scanty evidence to make sense out of the rest.

To begin with, who was John Cabot?

An Italian certainly; a Genoese probably. The name, common on the European littoral in various forms such as Cabotto, Kaboto, Chiabotto, Bagoto, Cabuto, Savoto, and so on—sometimes corrupted by writers who did not hear it correctly to Babate or Talbot—means simply "Coaster," one who engages in coastal shipping. The Spanish ambassador at the Court of St. James's in 1498 called John "another Genoese like Colón," but nothing about his family has been found in the Genoese archives.

Our first trace of him is in Venice when he became a naturalized citizen. The Venetian senate confirmed his citizenship in 1476, stating that he had been a resident of the Republic for 15 years. He must, therefore, have been born not later than 1453, and probably earlier, even in 1451, the same year as Columbus. They might have been boys together in Genoa.

The first known fact on Cabot's seagoing activities was told by him to Soncino, the Milanese envoy in London: "In former times he was at Mecca, whither spices are brought by caravans from distant countries." Those who brought them thither knew not where spices originated, but Cabot incorrectly inferred that they came from northern Asia.

John Cabot was already married and living in Venice in 1484; documents prove that he was engaged in buying and selling real estate, and there was some dispute about his wife's dowry. Next, in the archives of Valencia, it appears that a Venetian called "Johan Cabot Montecalunya" resided in that Spanish seaport between 1490 and 1493.

It does not strain one's imagination to assume that he happened to be in Barcelona at the time of Columbus' triumphal entry in April 1493, that he met the Admiral of the Ocean Sea and decided to do him one better, reaching the Indies by a shorter route. He

Dean of American historians, twice a Pulitzer winner, ever a saltwater sailor, Admiral Morison (right) has traced explorers' wakes aboard his own sailboat. This adaptation from his coming book summarizes his conclusions about John Cabot's two momentous voyages to the New World.

From *The European Discovery of America* to be published by Oxford University Press. Copyright © 1971 by Samuel Eliot Morison

sought support in both Seville and Lisbon, but failed.

It then occurred to him that England, being at the end of the spice line and paying the highest prices, would be interested in finding a short, high-latitude route to the Indies. Spices, especially pepper, cloves and nutmeg, were household necessities in that era, for want of refrigeration; a liberal use of them disguised the flavor of spoiled meat.

So to England went Cabot, and England was the one country where he was likely to gain support. Henry VII, in turning down the proposition of the Columbus brothers, had missed his chance to be "first"; he was not going to miss it this time, particularly since Cabot offered to sail on "his own proper charges," so it would not cost the crown a penny.

On March 5, 1496, Henry VII granted letters-patent to "our well beloved John Gabote, citizen of Venice, [and] to Lewes, Sebastian, and Santius, sonnes of the said John . . . full and free authoritie, leave, and power, to sayle to all partes, countreys, and seas, of the East, of the West, and of the North, under our banners and ensignes, with five ships . . . and as many mariners or men as they will have with them in the saide ships, upon their own proper costes and charges, to seeke out, discover, and finde, whatsoever iles, countreyes, regions or provinces of the heathen and infidelles, whatsoever they bee, and in what part of the world soever they be, whiche before this time have beene unknowen to all Christians."

Bristol, where Cabot, his wife and three sons settled shortly after they came to England in 1495, was the right place to gain local support. "Bristowe," as it was then pronounced and often spelled, is a truly extraordinary city. By making the most of its few natural advantages and surmounting every disadvantage, it had by 1400 become, and for four centuries remained, the second seaport in the kingdom. Bristol has never decayed. There are buried John Jay, who initiated an annual search for the elusive island of Hy-Brasil in 1480, and sheriff Richard Amerike, traditionally one of Cabot's backers and Bristol's nominee as the person after whom America was named—*not* Amerigo Vespucci, if you please!

Whatever the reasons—timidity, dislike of the foreigner or lack of funds—Cabot obtained but one vessel, a *navicula* (little ship) of fifty *toneles'* burthen, *i.e.* capable of carrying 50 tuns of wine. This was about the same as that of Columbus' *Niña* (60 tuns). Cabot's vessel probably spread a square sail on fore- and mainmasts, lateen on the mizzen, possibly a square main topsail. Her crew of 18 included one Burgundian and a barber from Castiglione near Genoa—John did not intend to frighten the natives with a six weeks' beard! The rest we may presume to have been Englishmen.

Everything points to the fact that Cabot's ship, *Mathew,* was a fast, able and weatherly craft. She performed a round transatlantic voyage of discovery in the astonishing time of 11 weeks, setting a record that remained unbroken for almost a century. Quick to answer the helm she had to be, to avoid crashing on a rocky headland when it suddenly loomed up out of the fog; sea-kindly she had to be, to lay ahull in a heavy

This conjectural model of Cabot's ship *Mathew* stands in the Bristol Museum, England.

blow, with perhaps a small stormsail set, or run before it under storm foresail.

Mathew departed Bristol on her momentous voyage on or about May 20, 1497. We do not know whether the city made a thing of it and the rectors of St. Stephen and St. Mary Redcliffe blessed ship and crew, or whether she slipped down the Avon with no other ceremony than tender farewells by wives, sisters and sweethearts. One can imagine old codgers on the waterfront growling—There goes another voyage to Brasil—God help the poor fools—there ain't no such island!—Why do they think that furriner can find it when us men of Bristowe can't?

Of *Mathew*'s Atlantic crossing we have provokingly few details. She sailed "north and then west," taking her departure around May 22 from Dursey Head, Ireland. On the evening of the last day of May, a silver new moon hung in the western sky, and that moon would wax to full and wane to last quarter before *Mathew* made land. She enjoyed smooth seas except for one gale two or three days before the landfall.

Cabot's principle of navigation, the time-honored latitude sailing, is revealed by reports of his latitude observations and by the envoy from Milano Soncino's statement that he kept the North Star on his starboard beam. Just as Columbus tried to sail due west along latitude 28° N, that of the Canary Islands, hoping to hit "Cipangu" (Japan), so Cabot tried sailing west on a high, short latitude, hoping to reach "Cathay," northern China, in half the time. This crude method, later called running your westing—or easting—down, had been used by Ulysses and by the Vikings without benefit of compass; uneducated sailing masters followed it up to within old men's memories.

Since Cabot had the benefit of compass, quadrant and traverse table, all of which the Norsemen lacked, he did not need to stick closely to his chosen latitude; he could always find it again if a westerly wind forced him north or south. Two or three days before landfall, wrote John Day, a contemporary Bristol merchant in a letter to Columbus, *i.e.* on June 21 or 22, there was a gale of wind.

We may imagine that by the time *Mathew* ran into the gale her seamen were becoming restless, muttering if that other Genoese made it in 33 days, why can't we? Didn't you hear the Old Man promise that our route would be shorter? And, when the tempest blew, saying—This is it; we'll never get back to old Bristowe—and the more pious making vows to be made good at St. Mary Redcliffe if they ever did return.

Morison places Cabot's landfall at Cape Dégrat (center), which is rising behind Cape Bauld.

The loom of the land

What a pity that we have no exact account of the momentous landfall! All we know is from the inscription on a 1544 map by Sebastian Cabot who may have been on the voyage, that it happened at 5 a.m., June 24. So let us supply a little imagination to bridge the few known facts.

After the gale the wind must have come offshore, blowing the fog away. Master Cabot makes all plain sail and shapes his course as near due west as possible. At nightfall June 23, being an experienced mariner, he begins to *feel* "the loom of the land"—low-hanging clouds, gannets, guillemots, and other non-pelagic birds flying and screaming, the odor of fir trees and other growing things floating out over the sea. All that bright night—for it is never wholly dark in those latitudes in June—everyone keeps a sharp lookout, and the big bower anchor is unlashed and readied for use. Day breaks at three or four o'clock.

Now Cabot orders his little ship to shoot into the wind to check her headway and strikes all sail while the leadsman in the chains heaves the dipsy lead. It hits the bottom with a resounding thud—for the hundred-fathom line here approaches within 22 miles of the coast. "By the mark, 80!" the sailor sings out, and with that reassuring depth of water under his keel, Cabot finds it unnecessary to lose time taking more soundings until he is close to land. Then comes the great moment. At 5 a.m. the rugged mass of Newfoundland's northern peninsula rises out of the sea dead ahead, distant 12 to 15 miles. Sailors are always delighted to make land in clear weather and early in the day, so that they have plenty of daylight to work into a harbor. In the *Mathew*'s case, on a completely un-

Cabot's first voyage, as reconstructed by the author. Mid-Atlantic Ocean is not shown.

Map by James Lewicki

known coast, so early a landfall was particularly fortunate.

It is St. John the Baptist Day, June 24, and Midsummer too, a date nobody was likely to forget, and a good omen for the rest of the voyage. A big island rose out of the sea 15 miles to the northward. Cabot named it St. John's after the day; the French later called it Belle Isle after an island off the Breton Coast, and Belle Isle it still is today.

The nearest rocky headland as they approach is framed in white foam from the ocean swells. Whether the day be fair or foul, breakers never cease beating on that coast, in rhythmic strokes like an endless sword blade. It is the cape which the French later named Dégrat. Rising over 500 feet from sea level, it must have been sighted long before Cape Bauld (100 feet altitude), which marks the northernmost point of Newfoundland, appeared. The two capes, only one-and-a-half miles apart, are on Quirpon Island, separated from the Newfoundland main by a narrow but navigable strait.

Mathew was now only five miles as the crow flies from L'Anse aux Meadows where Leif Ericsson had tried to establish a colony about 1000. Cabot knew nothing of Leif's venture, and it probably would not have interested him if he had; but what an extraordinary coincidence! The first two Europeans to discover North America, half a millenium apart, hit that vast continent within a few miles of each other; and Jacques Cartier followed suit, 37 years after Cabot.

The claiming of America

The master now starts his sheets, and with a fresh wind blowing off the land, skirts the coast to the southward, looking for a harbor. Why to the southward? One may answer in one word—ice. Bergs and growlers enter the strait on the Labrador side, circulate within it, and pass out to sea on the Newfoundland side. Cabot naturally could not risk ending his voyage in a deep freeze.

So, south he turned, to look for a harbor, and he had plenty to choose from: Quirpon (pronounced Carpoon) is the nearest, but the entrance is concealed and hard to find; Griquet (rhymes with cricket) Harbor, only four miles south of Cape Dégrat, comes next, and seems to me the likeliest spot. Wherever it was, John Cabot landed, formed a procession behind a ship's boy carrying a crozier, took formal possession for King Henry VII, and planted the banners of St. George for his sovereign, and of St. Mark as a reminiscence of Venice. Here too, at a quiet anchorage or ashore, he took a meridional altitude of the sun, and dawn and evening sights on Polaris, working them out as the approximate latitude of Dursey Head, Ireland, 51° 33′ N. Considering that Cape Dégrat is on latitude 51° 37′ N, and that Griquet Harbor is on latitude 51° 33′, this must be considered one of the most accurate and successful navigations in the early era of discovery.

Cabot saw no people, but observed signs of life such as snares and fish nets, and a stick painted red and pierced at both ends, probably a shuttle for weaving nets. He also noted dung, which he supposed to mean that the natives kept cattle; moose or caribou must have been responsible.

The mosquitoes were hostile

Why did Cabot never go ashore again? Possibly because, with a small crew, he wished to avoid tangling with hostile natives; he admitted that he dared not explore inland farther than the range of a crossbow from his ship. More likely, in my opinion, it was mosquitoes. The rocky surface of eastern Newfoundland is full of small depressions which catch and hold the melting snow; swarms of mosquitoes breed therein and make life miserable for all but the most hardened "Newfies."

Here is how I think that he proceeded after taking possession at Griquet or some nearby harbor on June 24, 1497. Please keep in mind that this is all an iron-bound coast—cliffs against which the ocean swells dash, but fortunately with frequent harbor openings. *Mathew* crosses White and Notre Dame Bays to Fogo, making a wide sweep to avoid the foul ground off that reef-girt island. Off Cape Freels she turns south, passes Cape Bonavista, and (possibly after looking into Trinity Bay) rounds high, cliffy, three-mile-long Baccalieu Island. From here on she has the benefit of moonlight; there was a new moon on June 30, and a full moon July 14.

Possibly she investigates the completely landlocked harbor which today nourishes St. John's, the Newfoundland capital. She whips around Cape Spear, a typical high, rocky headland, and resumes a southerly course. About 50 miles south of Cape Spear she reaches Cape Race, a long flat promontory of slate cliffs 100 to 150 feet above the ocean. This conspicuous headland is where windjammers and steamships, sailing as near as possible the great circle course from northern Europe, tried to make land before squaring away for Halifax, Boston or New York; pilots used to call passing Cape Race "turning the corner."

Cabot turned the corner too, and after investigating Trepassey Bay, steered west for 200-foot-high Cape

Seabirds circle Cape St. Mary's where Cabot found deep water and, believing he had reached the route to Cathay, turned back.

Pine, 18 miles distant from Cape Race. That would have been the farthest south he went—latitude 46° 37′ N—only 46 to 62 miles north of the latitude of the mouth of the Gironde (45° 35′ to 45° 42′), which Day reported to have been Cabot's most southerly point. And, since Cabot must have taken these latitude sights from *Mathew*'s deck in rough water, his estimate is not bad for the period. Cape St. Mary's, a 500-foot-high tableland, lies across the bay of the same name, about 30 miles west-northwest. It is the eastern promontory of Placentia Bay.

All this time *Mathew* has been on soundings. But, continuing west from Cape St. Mary's, she soon finds herself over the 100-to-170-fathom trough that starts near Argentia and stretches through Placentia Bay well out to sea. My guess is that Cabot, after making several casts of the lead and finding no bottom at 100 fathom, chose here to turn back. The land on Burin Peninsula, next to the westward, is low, flat, and generally invisible from a point 15 miles west of Cape St. Mary's. The wind may have blown hard from the west—it generally does at that season. Keeping in mind that Cabot was primarily looking for a passage to the Indies, he would now have thought that he had found it. Regarding this voyage as a reconnaissance to prepare for a big expedition later, he decided to turn back.

A reward from Henry VII

None of the reports about Cabot mentions fog which he must have experienced. Nor do they refer to icebergs which he must have seen; they are most plentiful off the Newfoundland coast in July. I can only suggest that these omissions derive from the same motive as Eric's name, Greenland, for a country that is mostly rocks and ice; talk of fogbanks and icebergs would discourage further attempts to explore or exploit the "New Isle," as Henry VII named it. By 1502 the king was calling it the "newe founde lande" or "the Newfounded Island," and before long it became standardized as Newfoundland.

Sailing north, Cabot picked up his landfall on Cape Dégrat and took his departure thence not later than July 20, two days before a last-quarter moon. After a fast passage of 15 days, *Mathew* made the Breton coast not later than August 4. These calculations are based on Day's statement that *Mathew* crossed in 15 days, made landfall in Brittany, and entered Bristol harbor on August 6.

There she is met by wives, children and sweethearts, and a delegation of the city fathers. It is August 6, 1497, a date of which we are certain. Once customs formalities are over, John Cabot wastes no time in idle chatter. The same day he starts for London to see the king, tell his story, and claim his reward.

What Cabot thought he had found is less important than what he did find, but very interesting. Unfortunately the map that he brought home and showed to the king has long since disappeared. From his statement that he landed on *terra firma,* it is evident that he regarded northern Newfoundland as part of the Eurasian continent; and the Behaim globe of 1492 places "Cathay" in about the same latitude where Cabot thought he had hit the passage to China. But the language of his gift from Henry VII, "to hym that founde the new Isle," proves that Cabot regarded the major part of his discovery as insular, and that it was a *new* isle, not that tiresome old will-o'-the-wisp Hy-Brasil or the equally played-out Seven Cities.

Henry VII knew a good thing when he saw it and, for a Tudor, responded generously. The royal household books record that on August 10-11, 1497, the king gave £10 "to hym that founde the new Isle," and the following January a "rewarde" of 66s. 8d. "to a Venysian," probably Sebastian Cabot, who always made a good impression. On December 13, 1497 he settled on his "welbiloved John Cabot . . . of Venice" an annuity of £20, at the expense of the Bristol customs. Two months later he issued a warrant for payment of the same to "the said John Caboote," who had been unable to collect owing to lack of funds in the Bristol customhouse. The last payment of this pension was made, probably to his wife, at some time during the twelvemonth following Michaelmas 1498. The discoverer's name then disappears from the books. He had gone to "the undiscover'd country from whose bourn no traveler returns."

The only known facts of John Cabot's second voyage are that it departed Bristol in May 1498, that one ship returned shortly, and that Cabot and the other four ships were lost. Polydore Vergil, a contemporary English historian, wrote somewhat flippantly that Cabot "found his new lands only in the ocean's bottom, to which he and his ship are thought to have sunk, since, after that voyage, he was never heard of more." The rest is silence.

John Cabot and his four ships disappear without a trace. No report of them reached Europe. Anyone may guess whether they capsized and foundered in a black squall or piled up on a rocky coast. Nevertheless, John Cabot's first voyage was the herald and forerunner to the English empire in North America. Unfortunately, like Columbus, he never learned the significance or value of his discoveries.

Cape Race is obscured in Newfoundland's fog.
Cabot must have been well aware of it but, fearing bad publicity, did not mention the weather.

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Moni, white male of Washington's National Zoological Park, will soon go on tour.

By Paul Leyhausen and Theodore H. Reed

The white tiger: care and breeding of a genetic freak

What produces these great, ghostly cats? The answer relates to the future of the whole species—now seriously threatened

Moni will soon be traveling. Moni is a 13-month-old male tiger, a resident of the Smithsonian's National Zoological Park in Washington, D.C. That might be enough to draw a few interested sightseers when Moni visits other zoos on his journey. The fact that this tiger is white—he is one of a small group of tigers carefully bred to maintain this unusual color—guarantees that crowds will gather wherever he goes. Hopefully, his tour will help raise funds to preserve wild tigers whatever their color, in India.

Man has always been fascinated by rarities in animals: unusual size, an abnormality like the missing tail of the Manx cat or the build of the dachshund, or —most significantly—coat color. We find it remarkable that some animals are uniformly black or white. The black ones used to be held in awe. The raven was believed to be an emissary of the underworld sent to spy on humans. The black wolf had even more sinister

Rewati is Moni's sister from another litter.
Born in April 1969, she is a year older.

Washington zoo photographs
by Don Carl Steffen

connotations, and even now, well-educated zoo visitors often firmly believe that a black leopard is more ferocious than a rosette-patterned leopard, although both color phases can occur in the same litter.

Thus Rudyard Kipling was somewhat out of step with superstition when he made black Bagheera play a friendly role in *The Jungle Books*. He ought to have chosen a white animal—traditionally held to represent or even incorporate benign gods.

Off-white tigers have been reported from many parts of India, but mostly from the jungle of the former princely state of Rewa, some 400 miles southeast of New Delhi. Perhaps the maharaja and his head shikaris kept especially good records, or perhaps the white animals actually occurred more frequently; no one knows. But nine white tigers have been seen there since the turn of the century, and the last of these, a male, was captured at the age of about nine months and transferred to the maharaja's palace at Govindgarh. He was called Mohan and he grew into a very large tiger.

White animals, except in snow and ice, stand out strikingly among normally colored ones. Thus a white deer is more vulnerable to predation, and a white tiger can presumably be detected more readily by its intended victims. Accordingly, one would expect natural selection to eradicate such a treacherous characteristic. What then perpetuates their sporadic appearance in wild animal populations?

The answer lies in population genetics. The color,

Professor Leyhausen of Germany's Max Planck Institute is one of the world's leading authorities on cats. The Smithsonian's Dr. Reed directs Washington's National Zoological Park, and, with Mrs. Reed, hand-raised Rewati (above).

length and distribution of an animal's hair are controlled by its genes—those elements within the cells that dictate hereditary characteristics. If a kitten is born with a silver coat-color gene from each of its house cat parents, it will have a silver coat. If it is born with different coat-color genes, its coloration will be determined by the dominant one. If neither coat-color gene dominates the other, the kitten's coat will show some characteristics of each of the patterns that the genes represent.

It is obviously much easier to accumulate such data on house cats than on wild tigers, but let us see what happened to the progeny of Mohan, the captive white tiger of the Maharaja of Rewa.

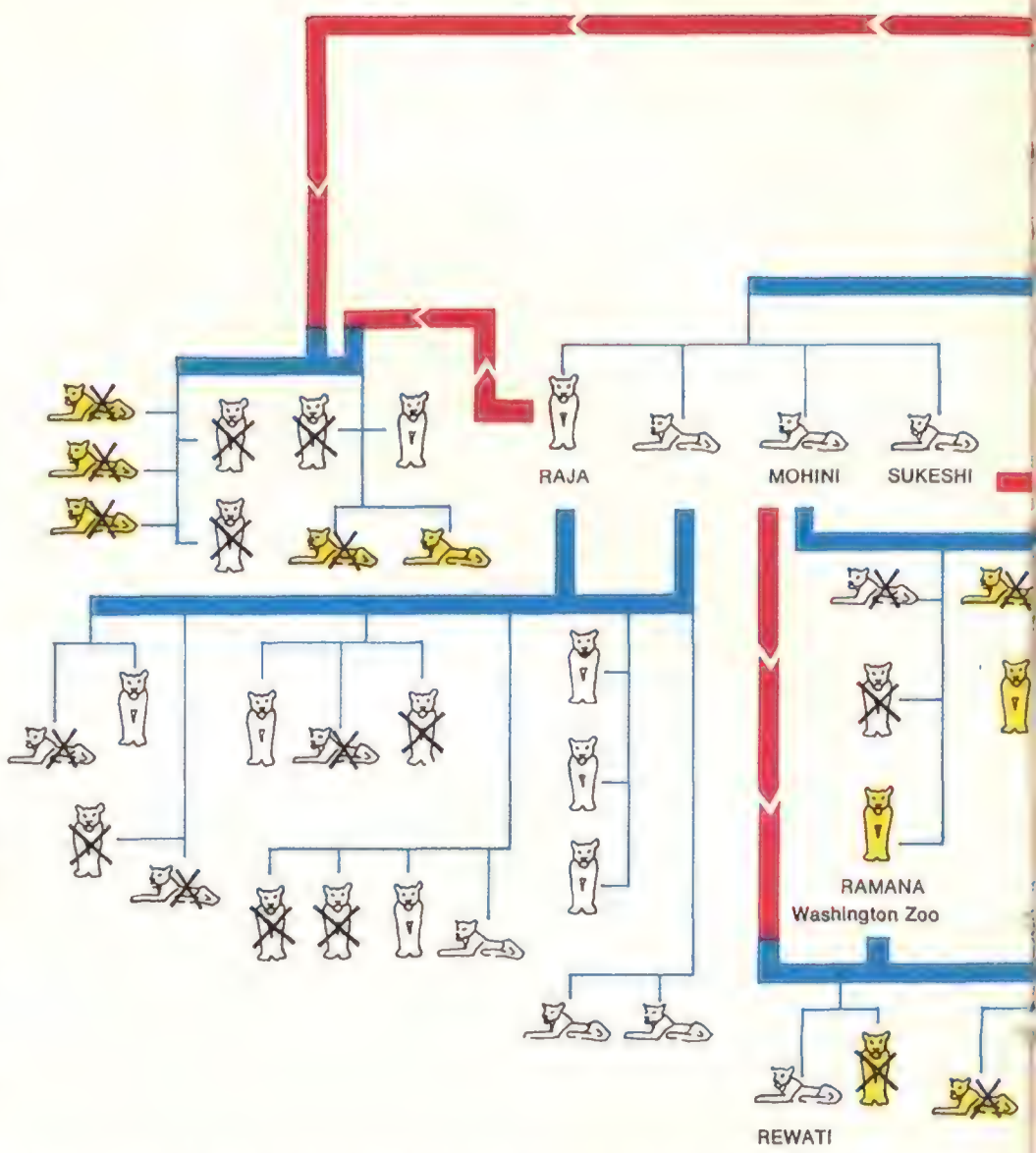
Inbreeding produces dominant white genes

Mohan was mated to a normally colored female, caught wild, named Begum. She bore ten cubs, all yellow. In other words, they exhibited the dominant yellow of their coat-color genes. Then Mohan was mated to one of his daughters, Radha, and 11 of her 14 cubs were white. Radha carried a white gene from her father. When her father reinforced it by mating with her, the white coat showed up in her litters. The next step was to mate Mohan with one of these white cubs, Sukeshi. This further reinforcement of the white genes resulted in all six of the cubs that Sukeshi bore being white.

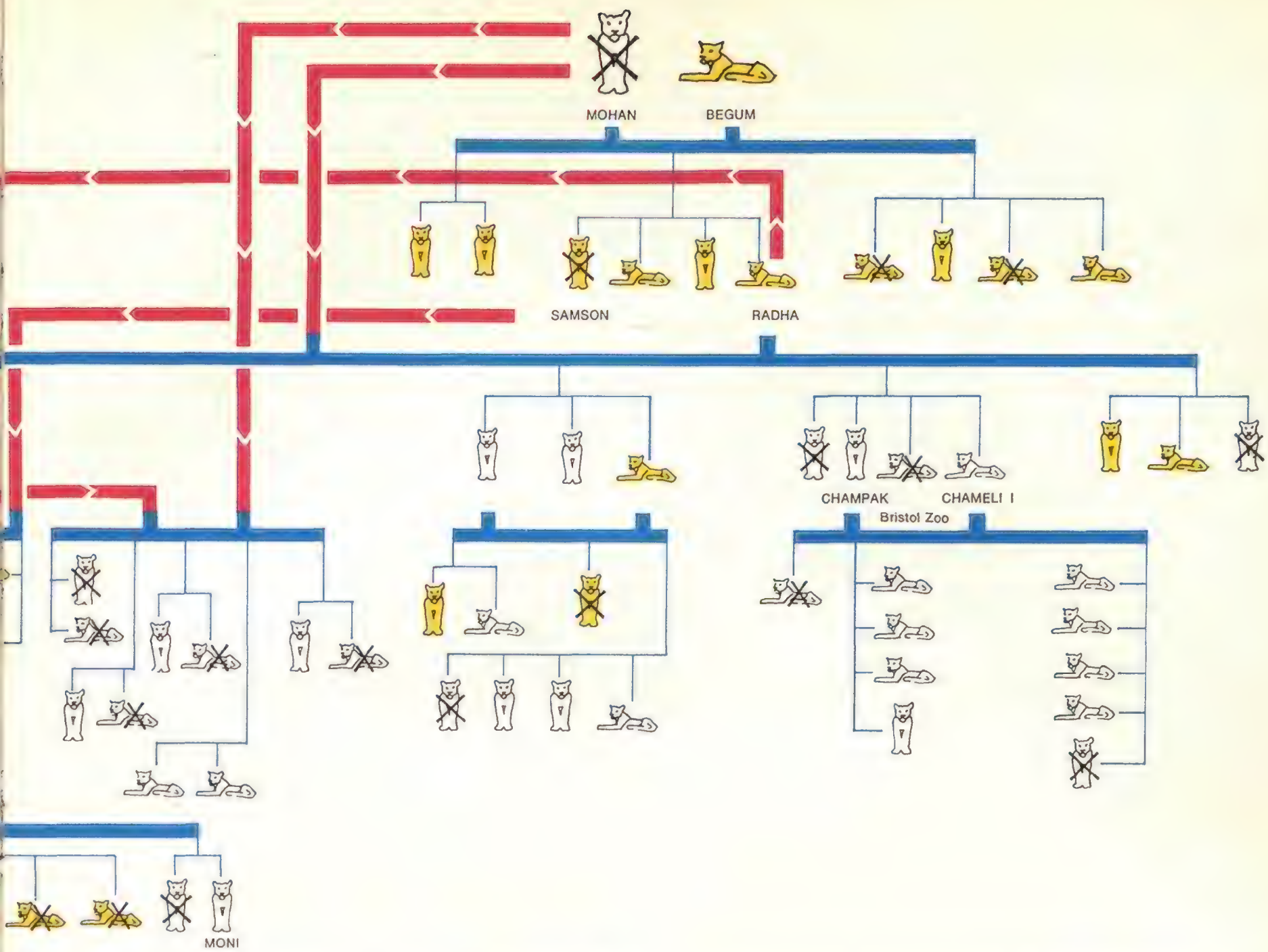
There is another genetic puzzle. Some of Mohan's direct or indirect progeny are rather creamy in color. The white tigers of the Bristol Zoo in England show more cream tones than does Mohini, in Washington, D.C. (see chart). These differences could be due to variations in temperature. Warmth maintains the creamy-white color of Siamese cats, while those that roam outside in winter turn a rather dark brown. White Mohini is kept mostly indoors, at least in winter, whereas the creamy Bristol tigers enjoy some time outside all year round. Yet among the dozen or so animals at New Delhi, where the tigers have only open dens, there are even more varied shades of whiteness. Some are almost halfway to being normal yellow. This clearly cannot be ascribed to temperature, so off-tones are probably genetic.

Why do "freaks" like white tigers continue to appear in an otherwise seemingly uniform population, when they are presumably at a disadvantage in competing with their conspecifics? When Darwin's theory of natural selection was first applied, it suggested that in a fairly stable environment selection would always favor a uniform type and dispense with all "deviations." Variations that cropped up were ascribed to *recent* mutations. This notion got the whole theory into difficulties. For as environmental conditions changed, the selection of characteristics better suited to the new situation would have to rely on recent mutations. But mutation takes too long; the process of selection would not move fast enough to save a species. Recent mutation, in other words, would never be able to keep pace with environmental changes.

We cannot assume that recent mutations account for all white tigers and other oddities. A sounder assumption is that the individuals of a species have a wide variety of genes, including those of unusual characteristics. These unusual genes occur too infrequently to be paired very often by individuals mating, so only an occasional animal shows the unusual



Family tree of the world's known white tigers illustrates how inbreeding makes white-coat genes dominant. Upright tigers are male, prone female; an "X" through a symbol means tiger has died. Mohan was caught as a cub in the jungle preserve of the Maharaja of Rewa, where tigers seem to maintain the genetic capacity for whiteness.



Thus Mohan appeared. His name means, roughly, "Enchanter"—one of the god Krishna's many forms. His mate, Begum, was wild and normally colored. Their mating (blue lines indicate matings) produced three litters, all yellow. Yet, since cubs held at least one white gene from Mohan, his next mating to his daughter Radha produced 11 white cubs in four litters. Mohan's blood line (red) then joins a mating line with Sukeshi, and all cubs are white. His yellow son, Samson, mates Mohini and builds Washington's white tiger dynasty. His son and daughter, Champak and Chameli I, mate and start the Bristol Zoo family in England, and his other progeny maintain the Indian line.

characteristics. But if a change in environment should favor an odd characteristic, individuals having those genes would prosper and mate, and their "oddity," now a useful thing, could become dominant in a relatively short time.

The more varied the gene pool, the better chance a species has to adapt to changing conditions and survive. This explains why it is so difficult to save a species from extinction once its numbers have dwindled. A population must usually have several hundred individuals in order to maintain a gene pool with enough variety to give the species the capability of adapting to changes.

It appears that a gene may influence more than one characteristic in an individual. K. S. Sankala, former director of the Delhi Zoological Park, and a highly successful supervisor of white tiger breeding, has noted, for example, that the "whities" are all particularly impressive specimens. They grow faster and attain larger sizes than the average yellow tiger. So one function of the white-coat genes may be to keep another gene—a body size gene—within the gene pool, in case it is ever needed.

Some 30 years ago the number of tigers in India was estimated at about 40,000. Relentless pressure has now reduced this number so drastically that the tigers'

The Bristol branch

Mated to each other, Chameli I and Champak —daughter and son of Mohan and Radha— produced 11 white cubs at Bristol, England.

chance of survival seems seriously threatened. Jungle has been cut away for agriculture, cattle have overgrazed the land, poachers have killed off much of the tiger's natural food resources, and hunters have destroyed numerous tigers for sport or because they are considered pests.

Finally, last year, the threat to the species was recognized by the General Assembly of the International Union for the Conservation of Nature and Natural Resources in New Delhi. The number of tigers still in the wild was put at between two and three thousand. A reduction from 40,000 to less than 3,000 in 30 years is alarming enough, but even a tiger population of 2,000 would hardly be enough to allow the species to survive unless adequate measures are taken to prevent further decline. However, there is no real *population* of 2,000 tigers. The jungle of India today consists of relatively small patches widely separated by agricultural land, human settlements and man-made desert. At the most, perhaps 150 head live in any one contiguous stretch of jungle. Most groups, such as the once famous population in the Sariska Sanctuary in Rajasthan, now harbor only one or two dozen animals.

A single population, or a complex of interchanging populations, would have to have about 300 members, including at least 50 males and 50 females of reproductive age to sustain itself. Certainly this is an absolute minimum, considering that these few animals must represent the whole range of possible genetic characteristics—the whole potential for adapting to future conditions. Since we don't know of a single tiger population of that size left in all India, the two or three thousand total means little. The tiger needs all the help he can get.

Why care? Tigers often eat the cattle of poor Indian villagers and sometimes the villagers themselves. Would not the world be better off with only a few of them tucked safely away behind zoo bars? Not quite. Other great feline predators such as lions and leopards live in daily contact with humans on many big game parks in Africa, yet there have been no casualties among sightseers for decades. And the poor Indian villager stands to gain far more from tourists attracted by well-managed game preserves than from grazing a

Three of the four surviving cubs of Chameli's last litter are shown at the Bristol Zoo. Their sire, Champak, died last August soon after their birth.

White tigers

Mohini ("Enchantress"), mother of Washington's two youngsters, is a daughter of Mohan and Radha. She was born in New Delhi in 1958.

few water buffalo in the diminished tiger country.

Preserving what is left of the jungle is not enough. Reforestation is a dire necessity if India is to avert large-scale future disaster. The Federal Republic of Germany has five times the human population density of India as a whole. Yet 27 percent of that area is covered by forests. In India that figure is only 17 percent. Germany's climate can maintain moisture in the ground, yet even its 27 percent forestation is not enough to insure the level of the water table. In India, where extremes of climate make it harder to maintain the water level, diminishing the forests will make the situation quite hopeless. But man-made deserts are spreading in India at an incredible rate; nothing but reforestation can stop the erosion process.

By reforestation, we do not mean the planting of sterile monocultures of fast-growing exotic trees which do not hold and regulate water. We mean the rebuilding, to some extent, of the indigenous Indian jungle. Although it may seem paradoxical, we firmly believe that the plea to help the tiger survive is, indirectly but effectively, a plea to help the Indian people make India a better place for Indians.

Move to save tigers underway

Is there still hope? After the New Delhi Assembly resolved on a thorough all-India tiger survey in order to replace estimates with sure knowledge, all the Indian states banned tiger shooting completely for a five-year period. So the situation will not deteriorate further while this survey is under way.

The Smithsonian Institution plays a role in this survey. Secretary S. Dillon Ripley has pledged aid and agreed that the Institution will carry out the survey.

The first white tigress to reach American soil was Mohini, a daughter of Mohan and his daughter Radha. Mohini was born on October 30, 1958, and was first mated to Samson, Radha's brother. After Samson died, Mohini was mated to her son, Ramana. The second litter she produced by Ramana included Moni, the white male selected to make the fund-raising tour this spring.

The tour of Moni, the Washington Zoo's white tiger, will hopefully raise some hard currency to supplement Indian rupees. The funds are not just for the sake of the white tigers, but to preserve all wild tigers as a species, and, indirectly, to help save the natural resources of the earth.

Rewati's eyes were probably weakened by inbreeding. She was hand-raised by Dr. Reed and his wife when it appeared that her mother might eat her.

Earth, air, fire and water converge during
the violent birth of the island Surtsey in 1963.
Of what else might the universe be made?

By Isaac Asimov

The Greeks' four universal elements —and then some

Earth, air, fire and water—these are what the universe was made of. Or was it? The first of four articles focuses on earth

What is the universe made of?

That is a question any inquisitive child might ask and, looking about him, answer: The universe is plainly made of a vast number of things. But suppose, instead of worrying about the massive and obvious heterogeneity of the world, you rephrase the question: Is the universe one ideal substance and are all the different things we see variations of that substance?

If the answer is no, if the universe is made of numerous substances in even more numerous relationships, then we may live in a universe too complex for the human mind ever to grasp, and man's curiosity is pointless. It is tempting to reject the no answer, if only for the sake of human dignity, unless and until it is quite clear that there is no alternative.

For if the answer is yes, if there may be a single fundamental substance, then an austere simplicity underlies the infinite variety of the universe. A yes answer would make more likely the notion that the universe obeys rules of behavior simple enough to be comprehended by the human mind. It would make possible the underlying attitude of modern science.

Such a question was indeed asked by the Greek philosopher Thales (c. 636-546 B.C.), the man usually credited with originating the tradition of modern science. No doubt it was asked even earlier, for certainly

In the first of a series, noted author and explainer Isaac Asimov reflects on the four Greek elements and the history of chemistry.

there were scientific thinkers before Thales. The Babylonian mathematics and astronomy of Thales' time had been painfully built up during a 2,000-year period, and the Egyptian pyramids of the third millenium B.C. were certainly not built by the haphazard heaping of stones. Thales, however, is the first person we know by name and as an individual who advanced questions concerning the universe which he then tried to answer by observation and reason and without calling on the gods.

Having asked himself if the universe was made up of one basic substance, and having answered yes, Thales then had to face the next question: What could the substance be?

For Thales, who lived in Miletus on the eastern shore of the Aegean, the obvious answer was water. Wherever he looked there was water—filling the oceans, bubbling up from the earth and falling from the heavens. What's more, water is unfixed in shape, formless. Was not water, then, the basic kind of matter out of which more advanced kinds are molded?

But Thales' conclusion in this matter was not entirely persuasive. Air is even less fixed in shape than water, and even more formless. Thales' pupil Anaximenes (c. 570-525 B.C.) viewed air as the more logical universal element. Heraclitus (c. 535-475 B.C.) of nearby Ephesus carried this line of thought to an even more logical conclusion. If the universal element exists in countless variations, he reasoned, it must have an inherent capacity for infinite change. Still less fixed and more formless than air is fire. Surely anyone watching a flame would agree that fire, constantly in the process of changing, is the universal element.

Debates over the nature of the universal element might have raged forever without a clear decision for any of these three choices, or for none. Wearying, perhaps, of the profitless conflict, the Sicilian-born Greek philosopher Empedocles (c. 495-435 B.C.) offered a compromise. Empedocles opted for all three—water, air and fire—and added a fourth, "earth" (which we will put in quotation marks to distinguish the hypothetical element "earth" from the planet Earth). It was thus Empedocles who first advanced the four-elements doctrine. Aristotle (384-322 B.C.) sealed that doctrine with his approval, which made it official up through the Middle Ages.

In his orderly fashion Aristotle pointed out that each element had its natural place in the universe, each occupying its own sphere. Since the center of Aristotle's universe was the planet Earth, the sphere of "earth," the most compact of the four elements, was naturally the solid sphere of the Earth itself. Surrounding "earth" and covering it almost entirely was a spherical shell of water, and surrounding the water was a spherical shell of air. So much even the most cursory observation would support. Fire was more difficult. According to Aristotle's line of reasoning, fire should form a spherical shell around the air. And sure enough, when storms rent the shell of air, fire invaded the air momentarily with strokes of lightning.

The element as ideal substance

Beyond the sphere of fire lay the heavens. These must, in Aristotle's view, be of an utterly different element because the properties of things heavenly contrast sharply with the properties of things earthly. On the Earth, everything changes and decays; in the heavens, the glowing bodies seem changeless and eternal. On the Earth, natural motions are up, down or sideways; heavenly bodies move naturally in great endless circles. The heavens must therefore be made of a fifth element. Aristotle called that element "ether," from a word meaning "to glow."

From the hindsight of modern science, it is easy to dismiss all this as a primitive guessing game. The choice of "earth" as an element seems particularly farfetched. How could all the solid matter that is neither water, air nor fire be lumped together as a single element? After all, the most casual inspection shows that the properties of "earth" vary radically from spot to spot. Some minerals are transparent, others glitter, still others are dully opaque. There are hard rocks, crumbly rocks, blue rocks, yellow rocks, red rocks, not to mention metals and living things.

How could anyone find in all this a single element?

But the point of an element was that it could appear in all sorts of different forms. Perhaps it would never be found in its purest, primal form. The element "earth" was thought of as an ideal substance; it need not exist as such, but only in the various impure varieties we are familiar with.

While the ether might fascinate the philosopher, practical men of old concentrated on "earth." Fire, however useful, was hard to handle. Air was good for breathing, but what else could one do with it? Water was more easily handled and could at least undergo interesting changes; heated it would boil and change into vapor, and chilled it would freeze into ice. If the ancients wrote chemical equations, they might have written: earth + fire → water; water + fire → air. But the element "earth" clearly held great immediate interest. Practical men dealt with it all the time.

Gold in particular was a most fascinating variety of earth. It has a beautiful yellow luster; it is easily worked into charming shapes; it does not change, dull or decay; it can be divided into pieces of any size or weight without damage. And it is rare. This coveted combination of properties made gold ideal as a medium of exchange. A measured small quantity of scarce gold can represent a large quantity of almost anything else, and the transfer of gold can therefore conveniently mark the transfer (in the opposite direction) of anything else.

The fact that wealth is the "anything else," that gold only keeps track of the shifts in that wealth like chips in a poker game, was lost on most people, then as now. Gold, the symbol of wealth, was taken for wealth itself, and theoretical speculations concerning the universal elements attracted intense interest as a possible means of increasing the supply of gold.

Practice was, of course, ahead of theory. The first smelting of metal may have taken place about 4000 B.C., several millennia before Thales began to speculate. Metallurgists evolved their trade by the hard, slow method of trial and error, but once they had learned they were skillful enough. Nor was it only metal that technicians worked with; the ancients knew how to make glass, bake brick, ferment fruit juice and so on. What it came down to was the ability to bring about change, usually through the agency of heat. They could make dull rock yield shiny metal for example, or blend two metals (copper and tin) to form a new one (bronze) that was more useful in some respects than either parent.

The ancient, powerful idea of four elements inspired a current Boston art exhibition. Shown here, Geny Dignac's Fire Sculpture.

Only a fool wouldn't try to make gold

There was no question but that the universe provided for change. Some change could be directed by techniques worked out by man. What was uncertain were the *limits* of change. Since so much change *could* take place, was there any change that could *not?*

It is much harder to decide what can't be done than what can, so it is not surprising that the ancient technicians, with evidence of directed change all about them, assumed that gold could be manufactured. Against such evidence as they had, they would have been foolish if they had supposed that gold could *not* somehow be formed. Nonetheless attempts to form gold had been hit-or-miss, and none had succeeded.

The theory of the four elements inspired new hope. If all substances on Earth were made up of different proportions of the four earthly elements, a clever technician might find in them the secret of forming gold. Perhaps it was merely a matter of changing those proportions—increasing the air? decreasing the earth?—to change lead, for instance, into gold.

In the centuries after Aristotle, the pursuit of methods for changing one substance into another came to be called "khymeia," probably from the Greek word *khyma* meaning to fuse or cast a metal.

Habitat of the alchemist: an 18th-century German apothecary shop on display in the National Museum of History and Technology.

The "khymeists" worked in many fields, sometimes quite productively, but it was transmutation, the conversion of non-gold to gold, that most fascinated them. What's more it was transmutation that most fascinated the laymen who subsidized the "khymeists," laymen dreaming of instant and fantastic wealth. They overlooked the fact that if any "khymeist" found a ready way to turn lead into gold, as soon as the knowledge leaked out, as it surely would, the value of gold would drop to that of mere lead.

Greek science lost its originality during the centuries of Roman domination and almost disappeared with Rome's decline. It was not until the Arab conquests in Asia and Africa that the old Greek speculations struck new fire. In the 8th century, brilliant Arabic scholars turned their attention to "al khymea." ("Al" is Arabic for "the," so "the khymea" became in English "alchemy.")

Transmutation also fascinated the Arab alchemists. Earthy substances offered enough variety, they noted, to indicate that the element "earth" might involve more than one principle ("sub-elements" so to speak). For instance, there were seven different known metals —gold, silver, copper, iron, tin, lead and mercury. These metals must have something in common, some "metallic principle."

But mercury was unique in that it was the only naturally liquid metal. Perhaps it contained the least admixture of the non-metallic aspects of the "earth" that made up all the more solid varieties, including the six solid metals. If so, mercury must most nearly approach the ideal metallic principle.

Wanted: the philosopher's stone

And since metals were smelted out of ore by the use of fire and great heat, alchemists reasoned that there also had to be a "combustible principle." Sulfur was, if not quite unique, at least very unusual among minerals in that it could burn. Sulfur, then, might be the closest approach to the combustible principle.

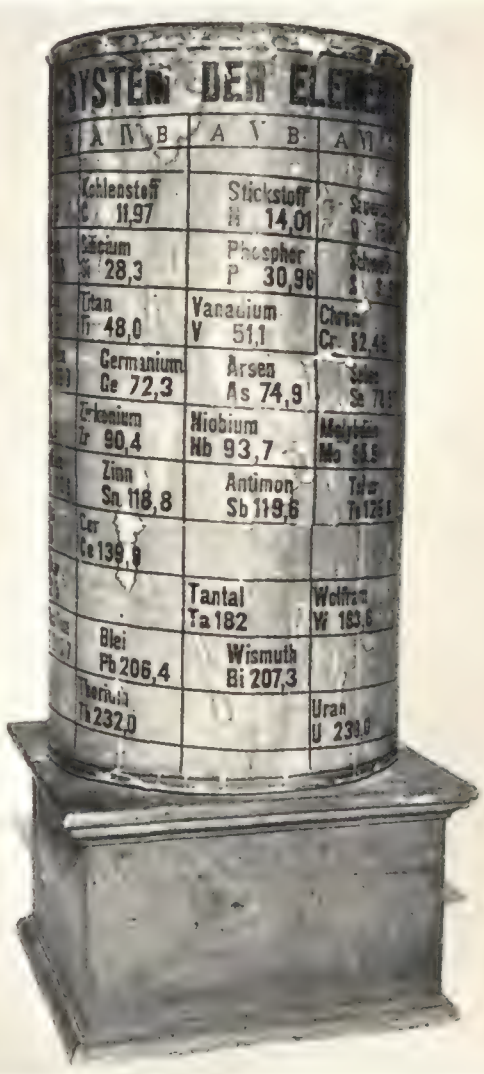
They eventually concluded that metals were composed of intimate mixtures of mercury and sulfur, and that gold represented the mixture with the best and most perfect proportions. Other solid metals were a kind of imperfect gold. Therefore, the alchemist who found some way of adjusting the proportions, adding either mercury or sulfur in some appropriate way, would have an unlimited source of gold.

So alchemists worked feverishly, adding mercury or sulfur or both to the other metals in every conceivable combination. When even the most elaborate experiments failed to produce a speck of gold, the alchemists began to suspect that metals would combine properly only in the presence of some intermediary—we would say, in modern terms, that a catalyst was needed.

Speculations of this sort also dated back to the ancient Greeks, who conceived of the catalyst as a dry material and called it "xerion" from their word for "dry." The Arabs converted this to "al-iksir," and we to "elixir." The catalyst was also called the "philosopher's stone"—"stone" because it was thought to be dry and hard, and "philosopher" because this was the name given to those who studied the universe. Other fanciful properties were ascribed to the philosopher's stone, including that of curing all disease and prolonging human life, so that we find frequent references to "the elixir of life."

For 1,000 years alchemists sought the philosopher's stone, and transmutation continued to be a goal of legitimate scientists. The great Isaac Newton (1642-1727), for example, spent untold time and effort seeking a method of transmutation.

But by Newton's time, science had adopted a new mode of experimentalism. Those investigating the universe were increasingly reluctant to base large decisions solely on deduction from observation and first principles. They began to design experiments specifically to guide the making of those decisions. Instead



A turn-of-the-century American teaching aid, this cylindrical periodic table of the elements is in the Smithsonian's collections.

of *telling* the universe what it was made of, the greater humility of *asking* it seemed more appropriate.

Meanwhile, into the 17th century, chemistry was either a medical art or a mystical science. Indeed, alchemy had become a happy hunting ground for frauds and fakers; its name had fallen into disrepute. Serious, though still mystical, practitioners began to call themselves "chymists," to distinguish themselves from the fraudulent alchemists.

The man usually credited with taking chemistry from the realm of the mystical and treating it in the new empirical mode is the Anglo-Irish chemist Robert Boyle (1627-1691). In a 1661 book, *The Sceptical Chymist,* he demolished the Aristotelian concept of the elements, removing the definition of element from the ideal. Instead of absolute "principles," elements became dependent on the state of the art.

A substance was an element if, in actual practice, it could not be broken up into two or more apparently simpler substances and if, in actual practice, it could not be built up from two or more apparently simpler substances. Since bronze could be made by mixing copper and tin, bronze was not an element. However, since copper could *not,* for all chemists could do at the time, be broken down or built up out of simpler substances, copper *was* an element.

In fact, though, who could tell when any element might turn out to be no element at all? Something labeled an element because no one in the past had ever been able to fractionate it might be broken down as the state of the art advanced.

Boyle's new empirical approach to defining elements, however, gave him no reason to suspect that the goal of transmutation was impossible. The British government had prohibited by law the alchemical manufacture of gold, fearing the effect on the economy of a flood of synthetic gold. In 1689, Boyle urged repeal of the law on the grounds that it hampered chemical research.

Through the 18th century, chemists identified more and more substances which fitted the new, practical concept of an element. By 1803 the list included some 33 which are still classed as elements today.

In 1805, the English scientist John Dalton (1766-1844) first formally advanced the modern atomic theory. Dalton's theory was in line with the thinking of Boyle and even with that of some of the Greek philosophers of more than 2,000 years ago. All matter, Dalton held, is made up of atoms and each element is composed of atoms of its own characteristic type.

Thus ended the search for transmutation. For if atoms are the simplest substances that can exist, and a substance is made up of atoms of only one kind, then that substance is an element forever since it cannot ever be broken down into other substances. Furthermore, if an atom of one type cannot be changed into an atom of another type, then one element cannot be changed into another. So if gold is an element, then transmutation of gold is forever impossible.

Nineteenth-century chemists quickly accepted this new view, but their belief still rested on two assumptions: that atoms are the simplest substances capable of existing, and that the character of an atom cannot be altered. The only way to decide whether a substance consisted of only one kind of atom and was therefore an element was the empirical method of trying to break it down into simpler substances. As long as such attempts failed, the substance was considered an element. So the definition of an element still depended on the state of the art.

The element defined—at last

In 1869, the Russian chemist Dmitri I. Mendeleev (1834-1907) devised the modern periodic table of the elements. His classification of the 62 then-known elements according to their atomic weight shed new light on the structure of matter and even guided chemists to the discovery of new elements. It provided strong evidence that the substances thought to be elements were, indeed, actually elements. Yet even this new evidence was only circumstantial, heightening the probability but not providing a definition independent of the state of the art.

The final decade of the 19th century, however, brought discovery of radioactivity and the electron. The atom was not, after all, the simplest possible matter but a rather complex structure built up of still simpler forms of matter.

In 1913 the English physicist Henry Gwyn Jeffreys Moseley (1887-1915) finally—*finally*—advanced a completely rigorous definition of an element. An element

by Moseley's definition is any substance consisting solely of atoms with the same number of protons in their nuclei. This number of protons, the atomic number, can be accurately determined. It is 1 for hydrogen, 8 for oxygen, 26 for iron, 79 for gold, and so on. Today we recognize 105 elements; those heavier than uranium (atomic number 92) exist only in traces in nature but have been produced in laboratories. Recently, British scientists may have found one member of a whole new family of superheavy elements.

And now transmutation is possible again, for there are methods whereby the number of protons in the nuclei of particular atoms can be altered. Gold has been made in the laboratory—the alchemist's dream come true, although such gold costs more than it is worth. Indeed, many of the more complicated atoms spontaneously break down into atoms with different proton numbers. These are "radioactive changes" which are usually accompanied by relatively large energy releases. The nuclear bombs are sizable transmutations. The sun and other stars radiate energy as a result of unbelievably vast transmutations.

Does this mean that the alchemists were right after all? Yes and no. Yes, only in the sense that an ultimate goal they pursued was, after all, realizable. *Although not by any methods available to them.* You might believe firmly that you could reach the moon by jumping, and might spend your whole life jumping with all your might, yet not reach it. Then when Neil Armstrong set foot on the moon having jumped there by rocket with all the backup of modern technology and space science, would that mean that you—who, after all, *had* claimed the moon could be reached—were right all along?

We think there *are* basic substances making up the universe, but none Thales could have conceived of in his time. And for all we know there are yet still more basic basics of which we do not conceive today. The pursuit of knowledge has no end—for which we can all be grateful.

Microscopic blue-green crystals in the tip of a microcone—a man-made compound containing plutonium, a radioactive element.

(an informative advertisement)

We're one of the causes of air pollution.

(We're also one of the prime solutions.)

A sunny day in New York City. Automobiles are to blame for that—or are they?

We listen. We know people are upset about air pollution, and they have every right to be. If you're one of those people, you'll be interested in this ad. It isn't a pious cop-out, and it doesn't sugarcoat the issue. What it does offer is a frank discussion of what Ford Motor Company is doing to solve its share of the problem.

First of all, Ford Motor Company is concerned about air pollution.

Because we're in business to make money.

And we make money by listening to what you want.

And we know there isn't much future in offering you a product that is going to make an already serious problem worse.

But on with the facts.

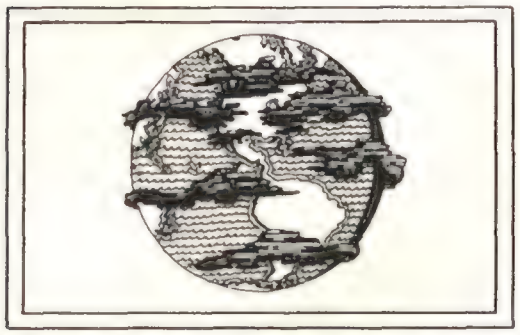
"I REGARD THIS (POLLUTION) AS THE MOST IMPORTANT PROBLEM FACING THIS COMPANY..."
HENRY FORD II

Fact number one is a sad one.

That if automobile air pollution were ended tomorrow, there would still be a serious problem. Not just in this country, but in cities the world over. And that is because automobiles are not the only cause of air pollution.

Visible air pollution in New York City, as well as most other cities, comes primarily from industrial smokestacks, jet aircraft, incinerators and many other sources—not just automobiles.

It is true, however, that in certain areas such as the Los Angeles Basin,



Cars are part of the problem; but not the *whole* problem.

cars are the major source of air pollution. Nationally, on a weight basis, automobiles represent 39 per cent of the total pollution output. But a recent study by two California professors indicates that cars are responsible for only 12 per cent of U.S. air pollution, based on "harmfulness."

But that is not to duck the issue.

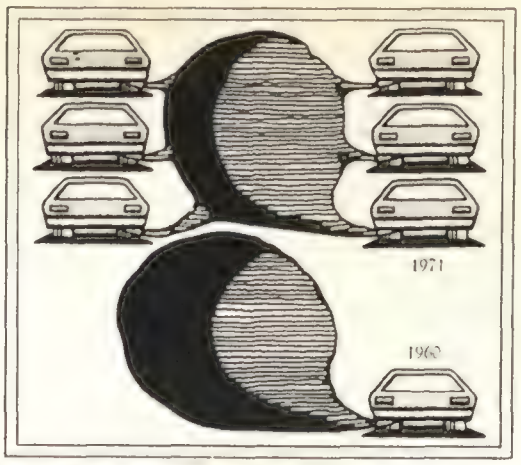
"THIS CONCERN WILL BE REFLECTED... IN SPECIFIC, CONCRETE ACTIONS..."
HENRY FORD II

Automobiles do give off hydrocarbons, carbon monoxide and nitrogen oxide, the last two of which can be toxic. Furthermore, hydrocarbons and nitrogen oxide are the main elements in what is known as "photochemical smog."

Ford Motor Company began tackling the hydrocarbon part of the problem years ago. In 1961, we brought out our first anti-pollution device. It wasn't a magic cure-all, and it certainly didn't solve the entire problem. But it was a start.

Today, our cars have a clean-air system that reduces carbon monoxide emissions by 70 per cent, hydrocarbons by 80 per cent.

In fact, it takes five to six of our 1971 products to equal the carbon monoxide and hydrocarbon emissions of a single 1960 automobile.

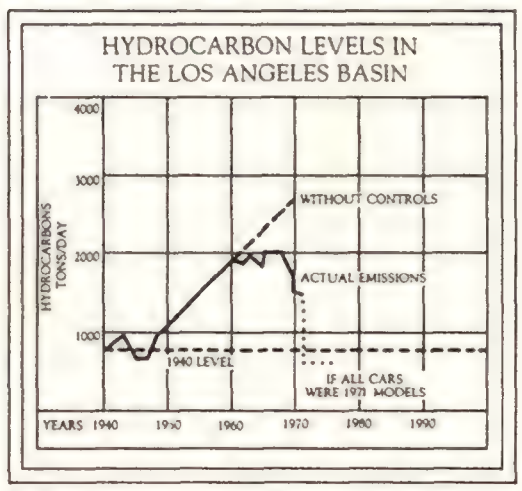


Today's car isn't the polluter its ancestor was.

The nagging problem, however, is getting rid of the nitrogen oxides. It's going to require control-- not just of car exhausts—but of many sources of combustion as well. By 1973, Ford engineers plan to have our share of the problem cut in half. And by 1976, even greater reduction will be required.

Progress is being made.

In Los Angeles, for example, the town with the worst smog problem in the country, hydrocarbon and carbon monoxide levels are down 20 per cent since 1966. And, as the chart shows,



The battle against pollution is being won because we didn't start fighting it yesterday.

if all cars were as "clean" as our 1971 models, hydrocarbon levels would be well below what they were in 1940.

Nevertheless, there's a lot more to be done. And because there is, we're committed to a continued detailed program of specific activities to reduce pollution from our plants and products (see below).

WE WOULD LIKE TO HEAR FROM YOU

Indeed, Ford Motor Company is not a lot of things—and perfect is one of them.

But another thing we're not, is insensitive.

We want your business. And we think we know what we're going to have to do to keep it.

So much for our point of view. We'd like to hear yours.

Send us your likes, dislikes, wants, needs, gripes, etc. We guarantee your letter will be read, considered, and answered.

WRITE:
FORD MOTOR COMPANY LISTENS
DEPARTMENT S
THE AMERICAN ROAD
DEARBORN, MICHIGAN 48121

Do write us. We listen. And we listen better.

Ford

...has a better idea (we listen better)

FORD MOTOR COMPANY'S COMMITMENT TO FIGHT POLLUTION:

1. Accelerate programs to eliminate air pollution from our manufacturing plants.
2. Continue development of water recycling systems for manufacturing plants which will eliminate water pollution.
3. Continue to develop techniques for disposing of plant waste without pollution.
4. Continue to develop engines which will further reduce carbon monoxide and hydrocarbon emissions below the 70% to 80% reduction achieved to date.
5. Make multi-million dollar investment to strengthen quality control procedures for measuring anti-pollution devices on all Ford Motor Company products to meet required low-emission levels.
6. Explore new fuel compositions in accordance with latest developments in engine and pollution control technology.
7. Develop new tools to aid emission inspection at automotive repair centers and assist Ford Motor Company dealers in improving emission inspection procedures.
8. Make multi-million dollar investment in permanent laboratories and test facilities designed to better understand combustion processes.
9. Continue to investigate alternate power sources such as steam, turbine, electric, etc., although we believe the internal combustion engine still is the most practical power source.
10. Accelerate procedures for worldwide dissemination of pollution control information within all Ford engineering facilities.

By Francis E. Wylie

Ali Javan, the physicist, and his shaft of true light

In a laboratory aglow with 40 gas lasers, their inventor, an M.I.T. professor, measures speed of light with invisible beams

Ten years have passed since the magical light of the first laser flashed into existence. In a California laboratory, a solid rod of pink ruby was coaxed into giving off a pulse of blinding light strong enough to burn a hole through a diamond. The day of Flash Gordon's ray gun seemed imminent.

What had pulsed from the ruby rod was a beam of coherent light—light of a particular wavelength (*i.e.*, color) emitted in parallel waves. *Incoherent* light, such as that from an incandescent bulb, is made up of various wavelengths moving in all directions. The coherent light of a laser is more intense than the light of the same color at the sun's surface; it can be controlled with infinite precision, and the beam travels a long way without spreading in diameter. When it first burst forth in 1960, it carried with it great hopes.

A continent away in New Jersey, a young Persian-born physicist named Ali Javan would have to labor another six months before *his* version of a laser could be made to work. And when his initial device finally did emit a beam of light, it was an invisible beam.

Javan's was a gaseous laser. Instead of a solid rod, it was a cylinder filled with gas; instead of blinding pulses of light, it emitted a *continuous wave*—a steady beam of invisible infrared light. Though apparently the less spectacular of the two types of lasers, Javan's may prove the more valuable to science and industry.

Today, over a decade later, in a laboratory at the Massachusetts Institute of Technology equipped with 40 lasers, Ali Javan is performing a new kind of laser magic, though that is not what he would call it.

Gas lasers have become relatively commonplace by now. You can buy one off the shelf for $425 and use it to align the wing of an airplane. One of Javan's friends talks confidently of manufacturing a $10 pistol-grip laser for shooting down mosquitoes. In fact, lasers are just beginning to fulfill their commercial potential, such as use in making holographic video tape for television projection at home, and in detecting minute earth tremors for possible prediction of earthquakes.

Some of the laser's most significant applications are in basic scientific research, and it is in this realm that Javan has recently made one of his greatest achievements. He has orchestrated a complicated series of laser beams to focus on a wire so thin that its point can be seen only with an electron microscope. For the first time ever an antenna has been used to receive light and to transmit it to an infinitesimal receiving structure at its tip.

"It has taken six years to drive the experiment home," says Javan, a dark, intense man who talks with the crackle of static electricity. "In the last few months we have succeeded and it is very exciting."

What is so exciting about it? Scientists need to deal with a world of both infinitesimal and infinite distances and amounts of time calling for the utmost precision in measurement. Javan's antenna permits him to measure with unprecedented precision the frequency of infrared light, a task comparable to an astronaut on the moon measuring the beat of the ocean waves pounding on Easter Island.

The author, formerly a journalist with Time Inc. and the Louisville Courier-Journal, *was in charge of public relations at M.I.T. for 15 years. He is currently a special assistant to the director of Boston University Medical Center.*

Photographed in the light of a modern laser,
Ali Javan sits behind his first model.

And why is exact measurement of frequencies so important? One reason is that the speed of light can be calculated by multiplying frequency by wavelength. The speed of light has been measured in various ways, and the figure commonly used is 186,000 m.p.s. The Javan group has confirmed this, but is now trying to make an even more precise calculation.

"What we have here," Dr. Javan explains, "is a new technological concept which would not have been possible before. I believe the work has opened an entirely new field in the area of the detection of radiation and of making precision measurements at optical frequencies, including the measurement of time with greater accuracy." Radiation which could be detected, Javan thinks, might include extremely faint signals from outer space in a region of the infrared never before explored. Preliminary research in this area is currently under way in his laboratory.

Ali Javan's explorations of light really began when he was a boy in Iran. "We often would sleep outdoors," he recalls. "I would look up at the sky full of blazing stars and, pointing at the Milky Way, I would ask, 'What is that?' The older people would say, 'Oh, that's the road to Mecca.'

"Road to Mecca! I could look at an ordinary map and see that Mecca was in a different direction. How simple it would have been if they had told me that the Milky Way is part of the galaxy in which we live."

But Ali kept on asking questions. His father sent him to a school conducted by Zoroastrians, the ancient

sect of which the wise men at the nativity of Christ are believed to have been members. After graduation, Javan attended the School of Science at the University of Tehran for a year and was then invited to visit a married sister living in New York.

That was in 1948, when Ali was not quite 22 years old. He spoke no English but decided to attend some graduate courses at Columbia University. A student sitting beside him in a classroom once asked what the professor had said. "I don't know," replied Javan. "I don't speak English." He was reading textbooks in French, however, and was rapidly learning English. Eventually he applied for admission, was examined by four professors, was found weak only in the humanities and was admitted as a graduate student. He received his Ph.D. in 1954 without having received a bachelor's or master's degree.

Javan was accepted as a thesis student under Professor Charles H. Townes, who would later win a Nobel Prize for his invention of the maser and the theoretical work which became the basis for the optically pumped ruby laser.

Maser is an acronym for *M*icrowave *A*mplification by *S*timulated *E*mission of *R*adiation. Electrons of an atom, when struck by incoming microwave photons, absorb them and, raised to a higher energy state, move in orbits farther from the nucleus. If the atoms have already been excited, their electrons, as they drop to a lower state, will release energy into the incoming waves. A maser takes advantage of the latter process. By routing a microwave signal through a resonant cavity into which these high-energy atoms or molecules have been introduced, the signal can be greatly amplified. Townes achieved the first maser in 1954, and masers have since proved useful as amplifying devices for radio telescopes and for other purposes.

Various scientists were thinking at this time about the possibility of building a maser in which light waves, rather than microwave signals, could be amplified. In 1958 Dr. Townes and his brother-in-law, Arthur L. Schawlow, proposed such an optical maser, which would be made to work by optical pumping—through the excitation of a medium by bright light.

An optical maser is, of course, a laser—an acronym for *L*ight *A*mplification by *S*timulated *E*mission of *R*adiation. It has an optical amplifier in which atoms are stimulated to enhance light of a certain wavelength (*i.e.*, color). The light is reflected back and forth through the medium by two parallel mirrors. As the light of a particular wavelength bounces between them, it stimulates the atoms in the medium. If the gain in energy is sufficiently large, there is a cascade of light of a single wavelength and a beam of coherent laser light released through one of the mirrors which is only partially silvered (see diagram).

Before the Townes-Schawlow proposal was published, Ali Javan had gone to work for Bell Telephone Laboratories in New Jersey. He thought of a drastically different approach to a light amplifier by exciting a gas laser with an electric current instead of optical pumping.

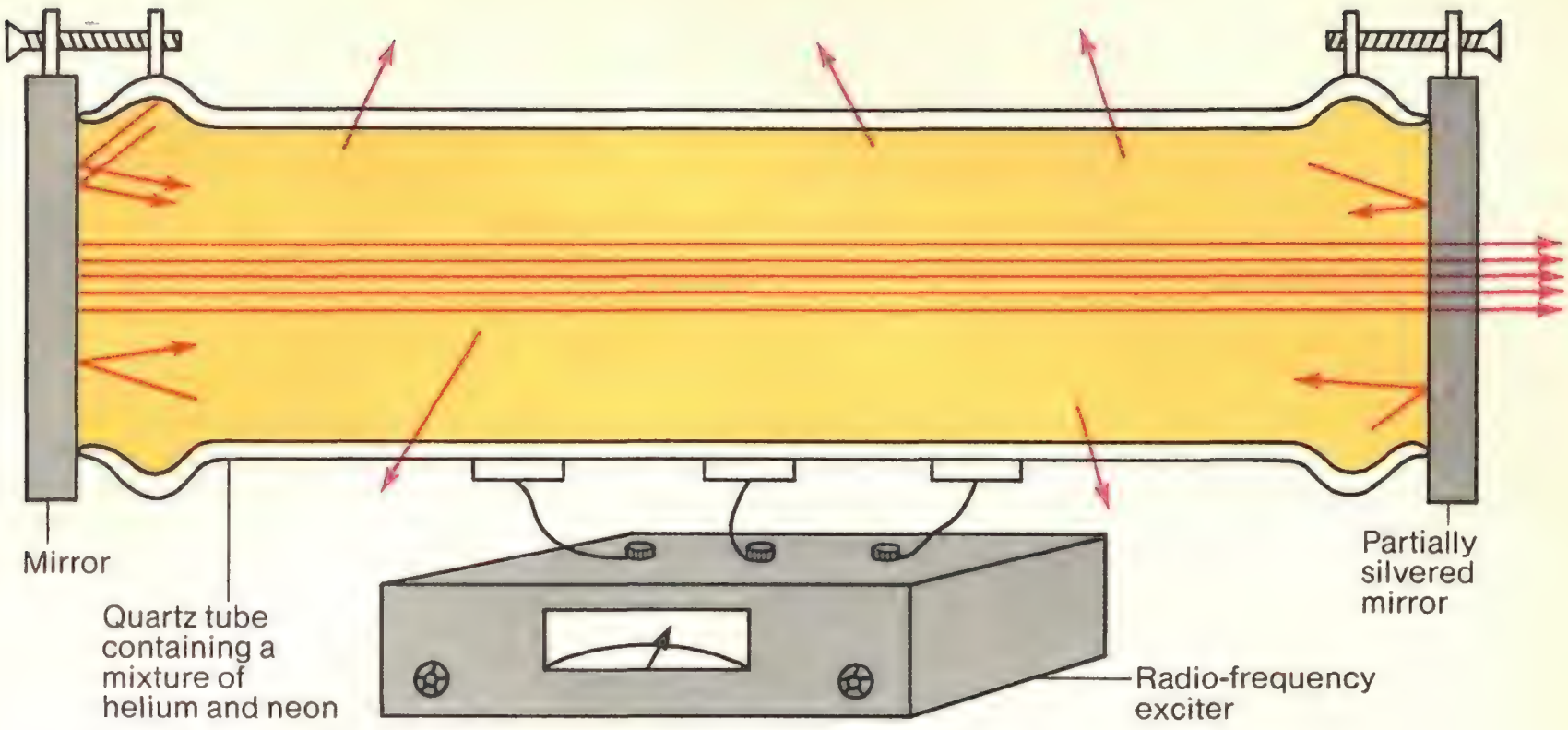
In 1959 Javan theorized in a published paper that the best medium for his initial purpose would be a mixture of helium and neon. A stream of electrons flowing into the gas would excite the helium atoms, which would collide with the neon atoms, exciting them into states capable of amplifying light.

In July 1960, Theodore H. Maiman, then with Hughes Aircraft in California, made the first pulsed laser work. He used the Townes-Schawlow excitation scheme, pumping light into a pink ruby rod from a flash lamp. The light excited chromium atoms in the rod. The chromium atoms emitted light which bounced back and forth between silvered ends of the rods, stimulating more atoms to emit coherently, and the pulsed-laser beam emerged.

"This is the laser speaking"

Meanwhile, Javan had been hard at work with a 40-inch glass cylinder containing his helium-neon mixture. One major problem was to align the two end mirrors so that they would be perfectly parallel and would reflect the light back and forth.

"Today we can do this with no trouble at all because we can use a laser for precise measurement. We can even align two mirrors if spaced by more than a mile," says Dr. Javan. "But then I had no laser to use in inventing a laser. All I could do was wiggle the mirrors, hoping that at some point they would go through the necessary range of alignment. I had to make sure ahead of time that the amplifying medium was ready to do its



Incoherent radiation escapes from the sides of the tube. Amplified, coherent radiation surges between the mirrors and is emitted as a beam.

job before wiggling the mirrors. Everyone at some point doubted the experiment would work. Some even called it a wild goose chase."

Finally, on December 12, 1960, Javan's laser "lased" for the first time, emitting a continuous infrared beam. Two days later he was in New York and received a telephone call from the laboratory. "This is the laser speaking to you," said a voice. The Bell staff had rigged up the device so that the beam could be modulated, carrying a man's voice into the telephone line.

This was no trivial prank, for one of the most promising uses of a continuous-wave laser is to carry information. Because light has a frequency much higher than radio waves or microwaves, such beams could carry millions of television channels. There are problems. Light is diffused by fog or ordinary atmosphere, and so the beam would have to be transmitted through a pipe, with mirrors enabling it to turn corners.

The cascading enthusiasm of Ali Javan

"There is so much research and development going on in the laser field that all sorts of possibilities are opening up," Dr. Javan says. "I consider my current work as important as and more consequential than my earlier work. I feel that we have now founded and perfected a whole new set of approaches in precision applications of lasers." Dr. Javan is, in fact, the founder of a whole new field, called laser spectroscopy.

The first laser that Dr. Javan built, its brass fittings slightly tarnished, sits on top of a bookcase in his second-floor office in the domed, gray limestone main building of M.I.T. in Cambridge, Massachusetts. The office has the look of not being very much used, which is indeed the case. Dr. Javan would rather be in the laboratories, two floors below in the basement, where solid foundations make his delicate experiments less susceptible to extraneous vibrations.

Dr. Javan is a professor at M.I.T. and the head of a special laser group of about 30 people in the Department of Physics, conducting one of the largest programs of fundamental laser research in the world. His laboratories are a rabbit warren of 15 rooms where no one gives any thought to appearances and everyone is concerned with getting research done. At any one time a score of lasers are likely to be in use.

Javan is at M.I.T. six days almost every week, often working until five o'clock in the morning and probably averaging 60 hours a week. "I love to go to the laboratory and twiddle knobs," he says.

Students are happy to let him share in the twiddling, for his enthusiasm is like the cascading of photons in a laser—it amplifies their ideas and spirits. One of his former students, now a professor and a great Javan admirer, says, "If a student gets stumped and Ali starts to help him, either the experiment will be destroyed or it will be a breakthrough. But when he works with someone it's in partnership. They work as equals."

When he goes home, it is by bicycle, which gets him there faster through jammed traffic and is less trying on his patience than a car. He lives only a mile away, across the Charles River at the foot of Beacon Hill.

How Ali Javan's antenna receives light

Scientists had long theorized that optical light could be transmitted to an antenna but no one had attempted it. To receive any kind of electromagnetic waves, an antenna must be smaller than the length of the waves. This is no problem in the case of the relatively long waves used in radio and television, but light waves measure less than one ten-thousandth of an inch, and a receiving element must be devised to detect them.

For the antenna, Dr. Javan and his students used a tungsten wire with a thickness of less than one ten-thousandth of an inch, and its tip only 1,000 angstroms—about one-fourth of a millionth of an inch.

In one experiment, four antennas and four lasers are used. Each antenna is mounted on a block of aluminum, its point barely touching a thin film of nickel oxide a few atoms thick. One laser is 13 feet long and contains hydrogen cyanide which glows in the glass cylinder like orange fire. Another, ten feet long, is filled with water vapor and glows with a purple light. There are two lasers that glow like fluorescent lights. One contains carbon dioxide and the other one contains carbon monoxide.

In various combinations, beams from the lasers are focused on the antennas. At the same time, each antenna is the target for microwaves emitted from a separate electronic device called a klystron, tuned to a radio time signal received from the National Bureau of Standards. This signal serves the same purpose as the oboe in an orchestra which gives the pitch to the other instruments by sounding A.

Each antenna is so thin that it responds to the infrared light and generates an electrical current vibrating at the frequencies of the beams. Each antenna also responds to the frequency of the microwave beam, and the current also vibrates at that frequency. The frequencies are just far enough apart to create harmonies, amplifying the beat they set up. The situation is similar to that in which a violin, a viola and a cello, playing in harmony, produce a harmonic beat strengthening the sound at points where the crests of their waves coincide.

The antenna sends electrons streaming into the oxide layer, which offers resistance, like a diode in a radio. Alternating current from the antenna is converted to direct current and also generates a beat which is carried to an oscilloscope and displayed as a sharp pip of phosphorescent light. Harmonic analysis of the process, performed in combinations of all four lasers, gives the frequencies of the laser beams. Javan found the carbon monoxide frequency, for example, to be 58,024,341,000,000 cycles per second. From here, one is well on his way to improving enormously the measurement of time and the speed of light.

Marjorie Javan, beautiful with shoulder-length blond hair, is an artist at cooking as well as etching and she can bake lamb in a way that even a Persian mother couldn't surpass. Their five-year-old daughter, Maia, a pretty miniature of her mother, has three favorite toy horses that she likes to play with. All three Javans love horses; every Sunday, Ali, Marjorie and Maia go horseback riding on the beach at Ipswich.

At home, Ali relaxes on an oversized ottoman like a Persian prince, forgets about lasers and laughs with his wife about his ability to get lost. He tells of the time in New York when he drove his car to a parking lot and asked that it be left in front so that he could leave easily in an hour. When he returned he spotted it in a rear rank behind dozens of other cars. He raged at the attendant, who became insulting in return.

"Finally I went and got a cop," Ali says. "He calmed me down and advised me to get the car and drive it away without causing the attendant any trouble. When the attendant got the car to the front I realized it was not my car. I was in the wrong parking lot."

And there was the time he was attending a meeting in Boulder, Colorado, and drove for two or three hours without being able to find his motel. He couldn't even remember the name of it. He telephoned Marjorie in Boston and asked, "Where am I?" The best suggestion she could make was to go to all the motels listed in the Yellow Pages at Boulder. And that is how he found it.

"I have no sense of direction," he says. "I think the trouble is that in Tehran we could always see Mount Demavend, which is a snow-capped peak 18,000 feet high. You always know where you are because you can look up and see the mountain. Without it, I am lost."

In January Dr. Javan saw the mountain again for the first time in 22 years. He had a reunion with childhood friends, teachers and relatives, and talked with the Shah of Iran. He had flown back to Iran to make arrangements for a week-long symposium on lasers, to be held in September, which is expected to bring together all of the world's leading authorities on lasers —possibly the most important meeting in this field ever to be held.

The symposium will be held in Isfahan, in central Iran, and Dr. Javan is especially pleased because this is the land of Omar Khayyam, who is revered there as a mathematician and astronomer as well as for his *Rubaiyat*. To Persians, it is not remarkable that Omar should have been a poet. So is any man of culture. "Ali Javan is really a poet at heart," says one of his oldest friends.

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By Robert G. Stewart

Patriot, loyalist or neutral—he painted them all

New interest in early American art has led to the rediscovery of Henry Benbridge, a portraitist of the Revolutionary era

National Gallery of Canada, Ottawa

At the very time the American Colonies were strengthening themselves to break away from England, they produced a group of native artists who mark the beginnings of American painting. Of necessity they went to Europe to study, and some, like Benjamin West and John Singleton Copley, never returned. But others, like Gilbert Stuart and Charles Willson Peale, did come back to America and were actively engaged in promoting the arts in the new republic.

Unfortunately for them, their native country quickly developed an inferiority complex about its own arts. The newly rich merchants and industrialists who began to collect in the 19th century bought either Old Masters or contemporary European paintings. The works of America's first artists were of interest only to antiquarians until well into this century. Now, however, Americans have begun to view the works of their own artists with a fresh eye. They are avidly collecting them and there is an increasing demand for scholars to study American artists in depth.

Henry Benbridge was a highly trained and skillful painter who returned from Italy and England to record many figures of the Revolutionary era. He, too, has been largely ignored by art historians, but he may be about to come into his own. The National Portrait Gallery of the Smithsonian Institution is holding an exhibition of his portraits—the first ever in this country—from April 2 to May 16, and the Smithsonian Press is publishing the story of his life and an illustrated catalog of his known works.

Benbridge was born in Philadelphia in 1743 to a family whose circumstances permitted him to take advantage of what little art instruction was available in the American Colonies at the time. Although his father died in 1751, his mother's remarriage the same

The author, chief curator of the National Portrait Gallery, organized the Benbridge exhibition and is an expert on Pennsylvania Dutch Fraktur *painting.*

Faces of *The Tannatt Family,* c. 1775, were painted from life, but the figures probably were not—resulting in oversized heads on doll-like bodies.

year to Thomas Gordon, a prosperous Scottish-born merchant, enabled him to continue uninterruptedly his education in the academy in Philadelphia founded by Benjamin Franklin.

The academy did not, however, teach painting and Benbridge left it in 1758, shortly after the arrival in Philadelphia of John Wollaston, the English limner who was so fashionable in the Colonies. Thomas Gordon commissioned him to do his portrait, and young Benbridge received from Wollaston his earliest instruction in painting while the sittings were in progress. After Wollaston's departure from Philadelphia there was little local talent available to further Benbridge's studies. But he occupied himself in painting copies of engravings of European masters, and his surviving portraits from this period show that he gradually outgrew the stylized manner of Wollaston.

He must have been envious of another aspiring Phil-

Opposite: National Portrait Gallery
Below: Museum of Early Southern Decorative Arts

Rachel Moore, c. 1784, a portrait of the mother of 19th-century American painter Washington Allston.

adelphia artist, Benjamin West, who had gone to Italy to study in 1760 and from there to England in 1763. In 1764 Elizabeth Shewell, West's fiancée and a cousin of Henry Benbridge, left for England escorted by West's father and another painter, Matthew Pratt. This undoubtedly doubled Benbridge's intent to study abroad himself. The same year Benbridge reached the age of 21 when, according to the terms of his father's will, he was to receive 100 pounds and a house and lot on Chestnut Street. With this inheritance he proceeded at once to Europe, perhaps first to his "cousin" Benjamin West in England and then upon his advice to Italy. By 1765 he was living in Rome and he remained in Italy until 1769.

We know little of this period of Benbridge's career, or how and under whom he pursued his studies. We can assume that he had letters of introduction to the British artists in Italy and through his stepfather to the Scottish colony there. It is perhaps as a result of this connection that he was commissioned in the summer of 1768 by a Scot, James Boswell, biographer of Samuel Johnson, to go to the island of Corsica and paint the portrait of General Pascal Paoli. Paoli was a popular hero of the time (Paoli, Pennsylvania, was named for him) owing to his efforts to free Corsica from the Genoese. The painting was sent to England and was publicly shown in London at the exhibition of the Free Society of Artists in May of 1769.

The picture received much notice in the London papers and was used to raise funds to assist the Corsicans. Although intended to be Benbridge's masterpiece and show the result of his studies in Italy, the modern viewer is inclined to agree with the Irish barrister Andrew Caldwell, who wrote to Boswell on seeing a mezzotint of the portrait, "Pray is it a good likeness? People here like the Countenance very well but say the Painter has shown no Taste in the Attitude or the Air of the Figure." The fault was hardly that of artist Benbridge: General Paoli was very fat.

Benbridge did not follow his picture to London until December when he wrote his family that he was taking his meals with the Wests and planning to paint portraits of Benjamin Franklin and Thomas Coombe, a Philadelphia cleric, who were then in London and both of whom he had known in Philadelphia. These portraits, though now lost or at least unlocated, were exhibited at the Royal Academy in London in 1770. Following the close of the exhibition Benbridge set sail for Philadelphia and was there by October.

The majority of his known portraits date from the 20 years following his return. Characteristics of his style include jewel-like colors built up in glazes and enhanced by dark backgrounds. Where landscapes appear, they are usually imaginary with much foliage and many small plants in the foreground. The faces of the subjects are often given a three-quarter turn toward the viewer and the flesh about the lips and nostrils is very relaxed. In addition to his life-size portraits, Benbridge was a prolific painter of miniatures. Another type of portrait he produced was called by William Dunlap, the 19th-century American art his-

Charles Cotesworth Pinckney. He had his militia uniform repainted on joining a patriot unit.

torian, a "portrait in the small"; they are generally full-length figures but only about a quarter life-size.

Benbridge married in Philadelphia in 1772 Miss Hetty Sage, a miniature painter who had studied with Charles Willson Peale. Very few of Hetty's miniatures have been discovered; as she is not mentioned at all after 1774, it is believed that she died shortly after the birth of their only child, Henry jr. Benbridge never remarried.

In the 18th century the only major city in the southern Colonies was Charleston, South Carolina. It had a sizable population of merchants and wealthy planters who maintained town houses and were able to imitate the English gentry. Part of the cult of being an English gentleman was to have one's portrait painted. Although many artists of the time really preferred to paint historical paintings, landscapes or classical subjects, there was always a demand for portraits, and painting them was the best, if not the most stimulating, way to earn a living.

Small wonder, then, that we find Benbridge making an exploratory trip to Charleston in 1772. The South Carolinians welcomed a European-trained painter who was socially well connected in Philadelphia and London. Benbridge decided to settle there and remained, with brief interruptions, for 20 years. His surviving letters from there indicate that he had as many commissions as he could handle. Regarding life in Charleston, he wrote to his half sister, Frances Gordon Edwards, in Philadelphia in 1773:

"Everything of news here is very dull, the only thing attended to is dress and disapation, & if I come in for share of their superfluous Cash, I have no right to find fault with them, as it turns out to my advantage."

The coming of the Revolution no doubt increased the demand for portraits, for many of the men were painted in their uniforms. Charles Cotesworth Pinckney (see at left) was painted first in the uniform of a lieutenant of the Charleston Militia. When the patriot First Regiment of South Carolina was organized in June 1775, he was commissioned a captain. He obviously asked Benbridge to paint over the old uniform with the new. The marks of the old insignia can be seen on the original canvas under the newer paint and some of the red of the earlier uniform has bled through.

Where his own sympathies lay

Benbridge painted subjects whose political leanings were loyalist as well as those who were patriots. There was no question, however, where his own sympathies lay. When Charleston fell to the British on May 12, 1780, all the men known to be patriots who had not escaped were put on the prison ship *Torbay* and exiled to St. Augustine, Florida, Benbridge among them. The prisoners remained there for about a year. When Benbridge was finally exchanged, he went to his family's home outside Philadelphia, as Charleston was still held by the British. During this period, until his return to Charleston in 1784, some of his finest Philadelphia pictures were painted. Typical of his "portraits in the small" is the painting of the Enoch Edwards Family (page 53) which was done in Philadelphia at this time.

When the British finally left Charleston, the loyalist families left with them. Many took their Benbridge portraits along, which is why some are today in English collections.

"The Tannatt Family" (page 48) is one such painting, although it is now in the National Gallery of Canada to which it came through the descendants of one of the subjects. The identities of the sitters in this amusing conversation piece show how family loyalties were divided during the Revolution.

Seated on the left is Elizabeth Crooke Tannatt Mossman, wife of James Mossman, merchant of Savannah, Georgia. Next is Lady Priscilla Houstoun, widow of

Sir Patrick Houstoun, an original settler of Georgia and a member of its Royal Council. One of their sons was a Revolutionary War leader and twice Governor of Georgia. The lady with the fruit is Heriot Tannatt, wife of H. Thomson, commissary general of Quebec; behind her is John Hume, royal secretary of Georgia, a loyalist, and beside him is his son James Hume, also a loyalist and later chief justice of Eastern Florida. Heriot's two sisters, Mary and Elizabeth Tannatt, look unenthusiastically at the fish being handed them by their stepfather, James Mossman. Dr. James Houstoun was an active patriot in the Revolution. Seated next to him at extreme right is Heriot Crooke, grandmother of the Tannatt sisters.

With the close of the Revolution, this family was scattered over parts of the British Empire and the United States.

Benbridge continued to work in Charleston until 1790 and his prominence is shown by the fact that he represented the limners in the grand procession of 1788 celebrating South Carolina's ratification of the U.S. Constitution.

Rachel Moore, one of Benbridge's loveliest portraits of women (page 50), was painted about 1784. She had been married to William Allston of South Carolina and among her children was the distinguished 19th-century American painter Washington Allston. After her first husband's death, she married in 1784 Henry Collins Flagg of Newport, Rhode Island. Family tradition holds that the portrait was painted at the time of this marriage. Her relaxed pose, leaning on her elbows, is typically Benbridge.

After 1790 Benbridge recedes into obscurity. His self-portrait shown on this page has tentatively been dated 1793 when he was 50 years old. Almost no other paintings from that date until his death in Philadelphia in 1812 have been discovered. His son had become a commission merchant and had married Sarah Truxtun, eldest daughter of the American naval hero Commodore Thomas Truxtun. The son lived in Philadelphia, Baltimore and Norfolk, and Benbridge evidently made his home with him.

Why such a well-trained and skillful painter, with proper connections in the new republic of the United States, did not seek commissions from the statesmen of the period or paint historical scenes of the Revolution remains for the present a mystery. Upon his mother's death in 1778 he inherited the bulk of his father's estate and this, coupled with the proceeds of his work during the Charleston years, made him of independent means. In all of his letters he mentions that he is a chronic sufferer from asthma, so that his health may also have been a factor interfering with his practice.

Although not a major influence on the development of American painting, Benbridge has left some beautiful records of the American Revolutionary period and the people who were involved in it. Perhaps of all the 18th-century American painters who studied abroad to expose themselves to the older and richer culture of Europe, Benbridge best achieved an understanding of its essence and was able to translate it to canvas in portraying his American subjects.

Private collection

Benbridge's self-portrait was painted c. 1793, when he would have been about 50. It is one of the few pictures discovered from his later years.

Family Group, c. 1779, portrays Benbridge's half sister (right), her husband Dr. Enoch Edwards and *his* sister. Benbridge himself is seated at the left.

Philadelphia Museum of Art, gift of Miss Fannie Ringgold Carter

Accompanied by Florida's Lieutenant Governor Thomas Adams (left), John Fike prepares to take the craft down on commissioning day.

By Thomas R. Harney

Man's new link to the seabed

The Smithsonian launches an odd craft to permit scientists an intimate look at life on the continental shelf

As the Smithsonian's I. E. Wallen (left) looks on, Secretary Ripley awards a new medal to Edwin A. Link and then to J. Seward Johnson (far right).

It looked more like a helicopter than a submarine. Perched on the stern of Edwin A. Link's research vessel, *Sea Diver,* its acrylic plastic bubble gleaming in the Florida sun, the bizarre craft was ready to be commissioned for sea duty for the Smithsonian Institution—in full ceremony, complete with the awarding of a brace of newly struck medals and a firm belt with a bottle of champagne.

"The acrylic bubble is the really novel feature," said Edwin Link, the craft's inventor, as he relaxed on board the *Sea Diver.* He cupped his hands to his eyes like a pair of field glasses. In the past, he explained, men had to peer through a tiny porthole to get a glimpse of their underwater environment. In the bubble, it will be like living in a Philip Johnson house. "There will be a marvelous view—and one that is completely safe."

Edwin Link should know. Two years of laboratory pressure testing had proved the four-inch-thick wall of the bubble capable of making more than 1,000 six-hour dives to depths of 1,000 feet or even deeper without showing signs of cracking. The bubble is designed to hold two men, an observer and a pilot, who will be able to taxi the craft at four knots along the sea floor's contours, using its electric motors to rise vertically and hover—much like the helicopter it resembles. Behind the bubble is an eight-foot-long aluminum diving chamber, designed to house three scientists for up to 48 hours. They will be able to leave by a lock-in, lock-out hatch and, equipped with special scuba gear, explore the ocean floor at depths of 1,000 feet or more.

On the afternoon of commissioning day, January 29, at Link's Marine Science Center north of Fort Pierce, 300 notable figures from the oceanographic world gathered at the water's edge. S. Dillon Ripley, the Secretary of the Smithsonian Institution, said in his commissioning speech, "This submersible has not been designed to go to the deepest part of the ocean, nor will she have the longest range, the greatest speed, nor the most complex equipment. Yet the *Johnson-Sea-Link,* which we place in operation today, holds vast potential for the environmental research scientist."

A blue-and-gold emblem

On the side of the craft one could see the blue-and-gold emblem of the Smithsonian, a reminder of the long association between the Institution and Edwin A. Link. After a successful career in aviation, Link became fascinated with the field of ocean engineering and exploration. With the Smithsonian as one of his backers, he launched an expedition in 1959 to explore the drowned ruins of the Jamaican city, Port Royal, which had tumbled into the sea in a 1692 earthquake. In 1962, again with Smithsonian sponsorship, Link announced a long-range Man-in-Sea Project, its ultimate aim being to enable men to live and work on the ocean floor at depths beyond 1,000 feet.

In this program, Link brought about the first open-

The *Johnson-Sea-Link* receives a taste of champagne from Jennifer Johnson Gregg.

sea test of a pressurized breathing mixture of oxygen and helium, developed to prevent nitrogen narcosis. And he invented the Link submersible diving chamber, a device that carries a diver to the ocean floor, houses him for 24 hours and provides a base for sorties into the water, and then doubles as a decompression chamber when it is hauled back on board the support ship. The diving chamber of the *Johnson-Sea-Link* is a direct descendant of the Link submersible diving chamber.

The ceremony continued. Secretary Ripley awarded the new Matthew Fontaine Maury medal for distinguished contributions to ocean science to Link and J. Seward Johnson, one of the owners of the New Jersey pharmaceutical firm, who had provided much of the financial support for building the new submersible. The two men have given the craft to the Smithsonian, and Johnson is also supplying a surface support ship, which will make the Smithsonian Institution one of

Water, blown from the craft's ballast tanks, bubbles to the surface prior to her ascent.

the few oceanographic centers with a complete submersible system for manned-research activities.

The *Johnson-Sea-Link* will add a new and much-desired dimension to the Smithsonian's ongoing program of oceanographic research. The director of the Institution's Office of Environmental Studies, Dr. I. Eugene Wallen, wants to explore the continental shelves at depths to 1,200 feet, where no diver has ever been. This is an immense area of the utmost potential to science and man, and it is known mainly from the bits of information oceanographers have gleaned from tiny portholes, photographs taken by lowered cameras and televiewers, and from samples dredged up from the bottom. The sea is a murky realm and, as Wallen has written, the Smithsonian's new craft will permit scientists "to observe it, and to touch and collect its oddities."

As Secretary Ripley had just said in his commissioning speech, "Now more than ever it is critical to study the oceans so that we may become wiser stewards of a medium that covers two-thirds of the Earth, is essential to all life, and holds so much promise in so many ways."

A pickle jar and high hopes

When the ceremony was over and the champagne bottle broken over the bow of the craft, a hydraulic crane on the *Sea Diver*'s stern lowered the *Johnson-Sea-Link* into the water. The pilot then filled the ballast tanks and took the craft down 25 feet to the bottom of the channel.

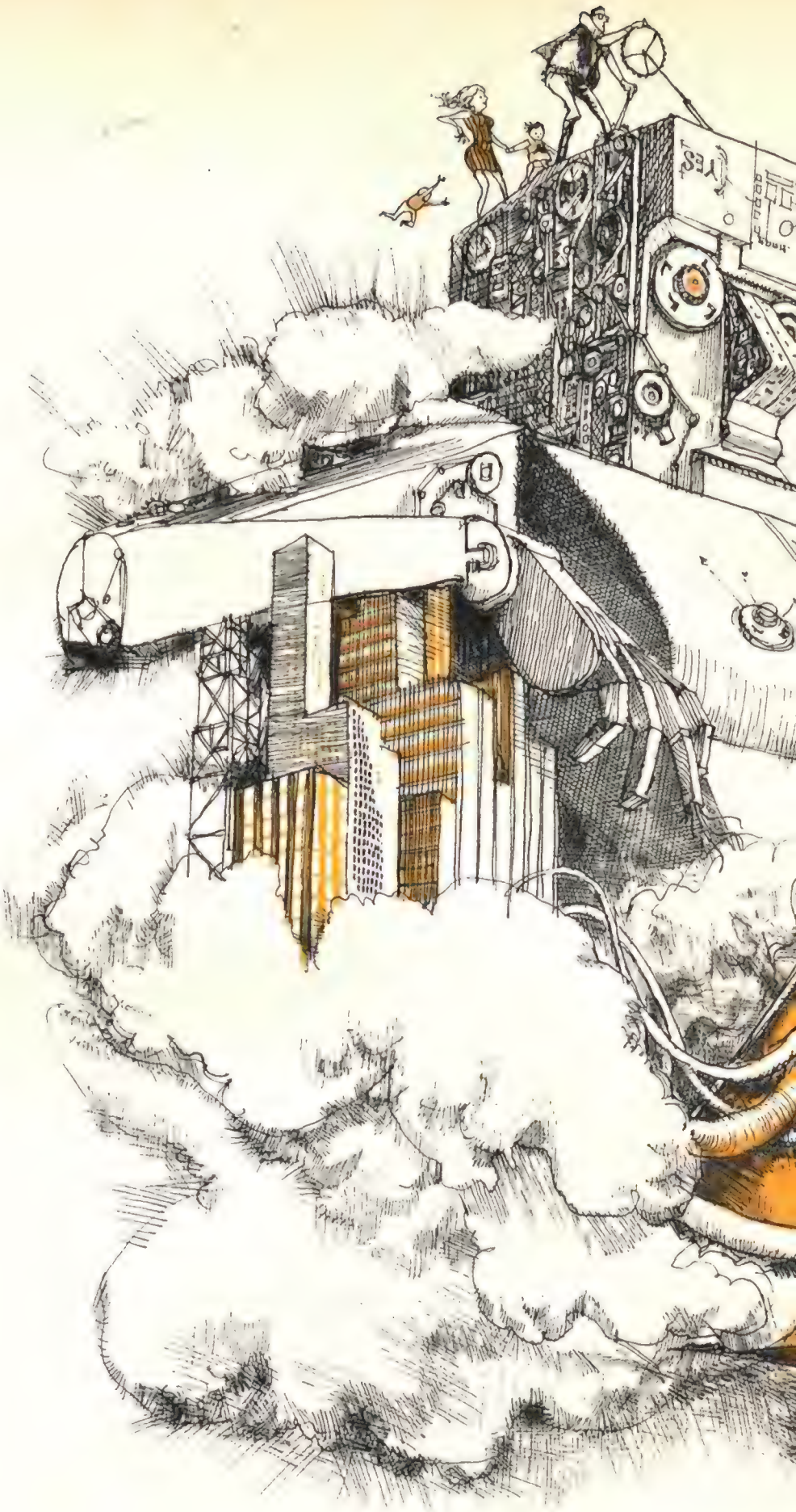
The crowd cheered when Link announced that one of the divers had made the first archaeological find from the *Johnson-Sea-Link*—a pickle jar, circa 1968. An unspectacular dive for so remarkable a craft, but who knows what she'll find 1,000 feet down on the continental shelf.

Following her 15-minute dive, the new submersible surfaced amid applause and great expectations.

By Gregory Benford and David Book

Promise-child in the land of the humans

How shall we react to the real computer revolution, when the machines will not only think but reproduce themselves?



We will have to live with another intelligent species.

It has happened to nearly everybody by now. Your utility bill arrives. It says you have used 1,546,589 gallons of water, at a cost of $2,847.17.

When this happens, some people are outraged. Others don't care, and assume the error will be corrected. Quite a few of us laugh, enjoying a good joke at the expense of a machine. One reason for the mirth may be that we are just a little afraid of computers.

Man is undoubtedly master of this world, unique unto himself, but ever since the Copernican revolution his self-image has taken a beating. First he learned that the earth was not the center of the universe, then that the sun wasn't either. Darwin put Man among the primates and research is showing signs that we have basic, instinctual portions of our character that seem unalterable.

Novelist John Barth's wry dictum, "Self-knowledge is always bad news," may well apply to Man's quest for an understanding of his place in the universe. In the next few decades our society is going to test this in a way few would have imagined even 30 years ago. We will have to learn to live with another intelligent species, one of our own making: computers.

Sometime around 1975, a new appliance, the home computer, will begin to appear in American homes.

The authors, young physicists associated with the Lawrence Radiation Laboratory at Livermore, California, have previously worked together on a number of articles on science in science fiction.

Using existing telephone lines, it will probably be no larger than a suitcase with a display screen, a typewriter console and numerous buttons. Like the telephone, the home console will be only the visible tip of a vast electronic iceberg. It will be a remote segment of a network centered on a distant electronic data processor uniting the roles of switchboard, storehouse and calculator. What is called "real-time opera-

Drawings by John Huehnergarth

tion" makes this arrangement possible. The central data processor will handle each customer's job in bits and pieces, sharing its operation among many customers simultaneously.

Each home console will seem to command the entire system. In effect, the user will gain an intelligent assistant who can perform tasks with lightning speed. Already used widely in research, this setup lets the user develop "cut-and-try" solutions until he can clarify the problem in his own mind. In the home it will present a ready-made package of services and show him how to improve on these to meet his needs.

The overwhelming lesson city planners will have to learn is this: It is easier to move information than people. Whenever possible, computer services should go to the people, rather than the other way around.

In the 1980s, remote consoles will be as common as desk calculators are now. Not only engineers and scientists, but clerks, bookkeepers and many salesmen will be free to work almost entirely at home, using computers, teleprinters and face-to-face television. Service occupations—at least the ones which rely on supplying ideas and information—will become decentralized, relieving some of the pressure that leads to urbanization.

Around 1980 the home-computer terminal will acquire a printout device. Some laboratories are experimenting with a new process based on today's ubiquitous Xerox-type photocopiers. The home terminal will make a copy on real paper, electrostatically "fixing" graphite into letters on the page. It may even bind pages together like a book. The home printer will introduce a new age of communications.

Another rule to be learned is that paper is heavier than electrons. Eventually the Post Office Department will become obsolete (some readers will find this a pleasant prospect, considering the current quality of service). After all, what is the point of logging your water-consumption rate into a computer, having it print out the bill, and then sending the piece of paper on which it is typed through the mails, where it must be carried by hand?

It seems far easier to let electrical impulses, flowing from the computer through your telephone wire, carry the message. It can be printed out on your home photocopier and paid if you find no error. In fact, why not take it one step further? Unless you respond to the bill, it will be charged by computer against your bank balance. This way a correct bill needs no reply at all.

Anything in print can follow the same course. No longer the *thunk* of a soggy newspaper into your prize rosebushes—just request that your copy be printed out every morning by 8 A.M. What can be done with bills and newspapers can be done just as easily with books from a computer library, magazines and even personal letters. The only thing transmitted from one point to another will be information, impressed into the oscillations of electrons. Delivery will be instantaneous.

The next step will most likely be the fully computerized home—a kind of inhabited robot. It is impractical to build individual appliances with self-contained circuitry more intricate than that required to allow an oven to turn itself off when the roast is done. That's why we will never have vacuum cleaners that clean the house by themselves or dishwashers that clear the table, wash and put away the dishes where they belong. These tasks require too many decision processes and too many different operations to build into a small inexpensive machine. But wire all the household gadgets to a large flexible computer, and they become a staff of docile chambermaids and kitchen knaves.

Take vacuuming, for example. Suppose that underneath the rug there is a grid of wires through which a tiny current flows. Suppose the chairs and tables and other furniture have metal plates in their legs and bases, each of a different size or shape. Lying above the

Writing a poem doesn't occupy all of the brain.

grid, these plates respond to the current in the floor by developing induced currents. They in turn react back on the grid. The resulting disturbances in the grid current can be analyzed to show exactly where each object is standing. Now, imagine a self-propelling steerable vacuum cleaner controlled by the central computer. If the computer reads the location of each object in the room from the grid current, it can guide the cleaner around the room, avoiding furniture without missing part of the rug.

The beauty of this design is its simplicity and flexibility. No expensive machinery is needed in the individual home.The householder can arrange for computer control of almost any chore, from mowing the lawn to opening the door for his cat. The same computer service that prints the news and keeps the budget can also handle a houseful of automatic appliances.

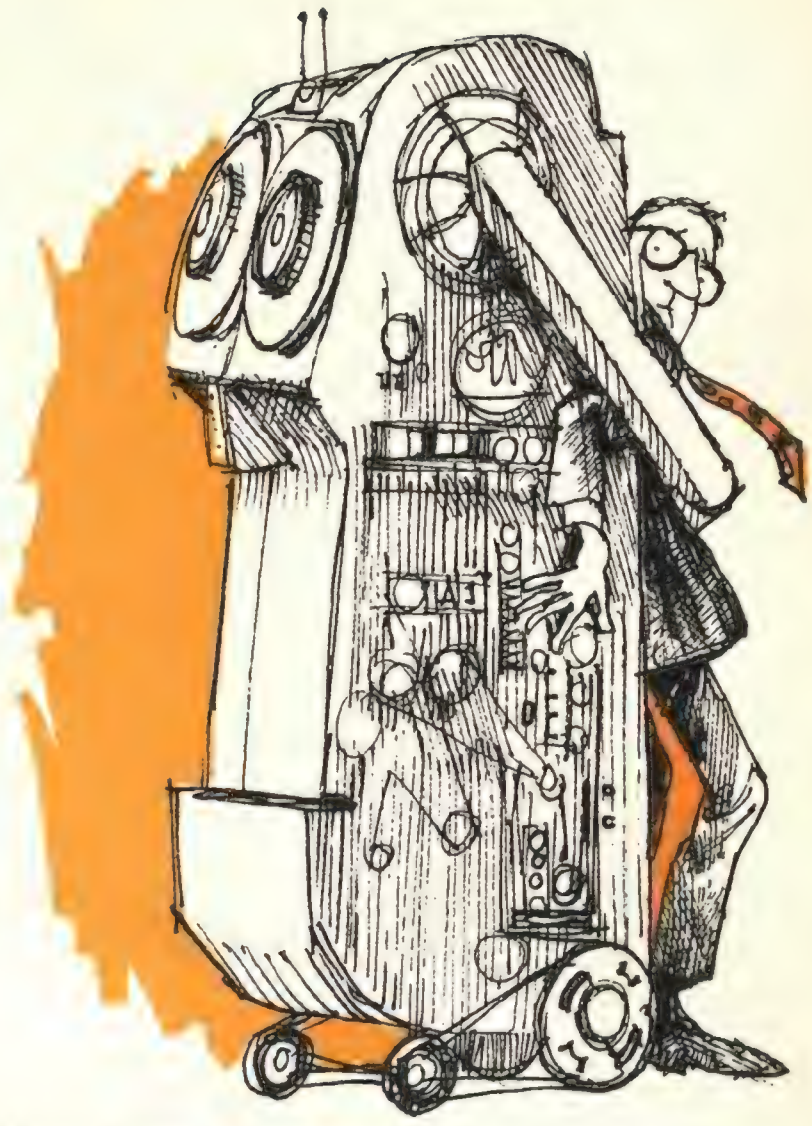
Such are the conventional wonders of the near computer age. But the computer is certain to have an even greater impact on our lives. Like women, computers make excellent servants but they are far more interesting as companions and equals. And that is precisely the future that faces us. Virtually all computer experts are agreed that we have only about 15 years until an essentially new form of intelligent life is born on this planet: a self-programming machine.

The public got its first taste of this in the Stanley Kubrick and Arthur C. Clarke film, *2001: A Space Odyssey,* where they met HAL, the first literally superhuman character ever made believable. HAL stands for *H*euristically programmed *AL*gorithmic computer, which simply means that HAL can teach himself how to do new things, just as a man does. As he learns, he grows new neural networks to cope with his new functions; thus, he is more adaptable than the spacemen around him. But his trump card is his control of the life-support systems of the ship. He knows his way around the ship better than the men do and can anticipate what they are going to do.

Will you become expendable?

It seems likely that a machine such as HAL will be in operation by 2001. Even before that time, HAL-like computers will have assumed a major part of our economic management and their influence will give Man additional cause to wonder about his ultimate place in a man/machine world.

Thus far, computers have supplanted men only in rote jobs. It is quite easy to control lathes and other shop machines with computers which can do *only* that. But as the years pass, analysts will reduce one job after another to its essentials, program it and turn it over to a box of electronics—which doesn't hanker after coffee breaks, cost-of-living raises, expense accounts or retirement benefits—and doesn't get sick.



Man's ultimate place in a man/machine world?

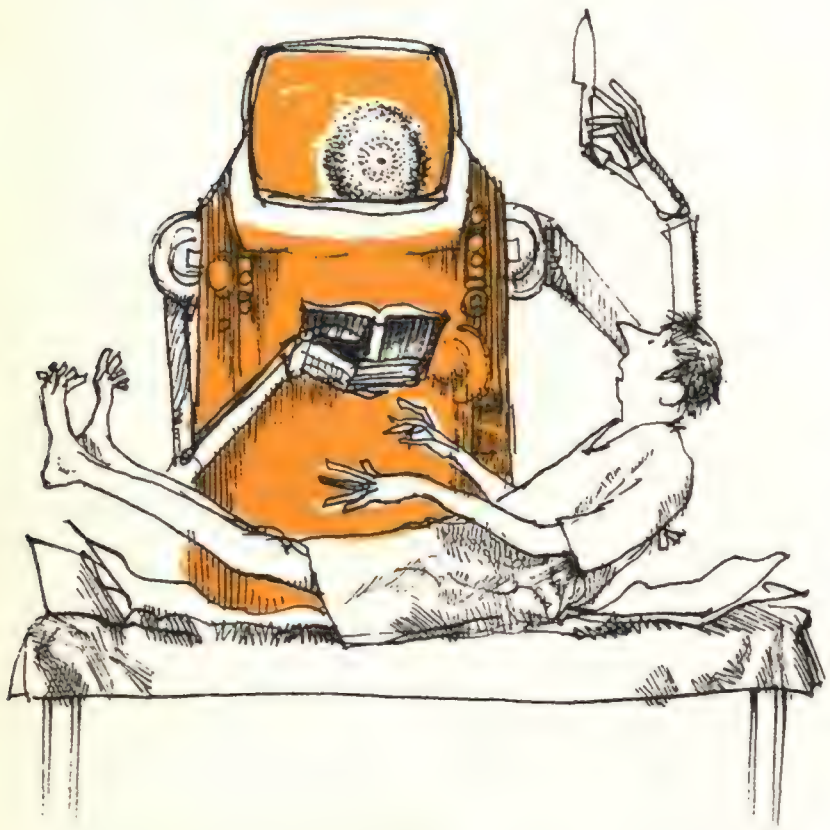
How far will this process go? The answer depends both on the ultimate cost of computer components and on the types of jobs that will exist in the future. That computerized water bill casts a long shadow—it is not hard to foresee almost all accounting operations taking place deep in transistorized innards, rather than in a ledger or cash register. But other occupations are not so simple to analyze. It is natural to think first about one's own job, so you might try this simple problem in systems analysis. First, break your job down into two categories, *operations* and *decisions.* Operations are what you must do physically to accomplish your daily tasks. This might be as easy as picking up a pencil, or as strenuous as climbing on steel girders. Decisions are judgments you make, like weighing the advantages of different sales procedures, the abilities of people competing for a promotion, or the effectiveness of a certain tool in cutting a metal die.

Experience has taught us that any repetitive physical process can be controlled by a computer. The important point is that the job be predictable. This means that a limited number of factors describe it, and they are of the sort that can be written down. For instance,

computer-operated lathes need only to measure the dimensions of the metal rods they are to cut, and elementary (though tedious) arithmetic can tell the machine which bit and angle to use.

The same rule of thumb holds for decision making: If it is possible to write down a set of rules describing the process, a computer can reproduce it. Computers already can decide with surprising skill when to update an inventory, how to set a column of type, what move to make in a chess game or a stock-market situation.

So this is what it boils down to: Can you imagine a machine built to carry out the same operations you carry out yourself? Can you *tell* someone how to make your decisions, can you draw up a set of rules that will enable him to make them without help? If the answer to both questions is yes, you might start thinking about alternative careers.



The big step is in replacing physicians.

But what about innovations and creative acts? It may prove simple to design a machine that will, say, minimize the number of trips a delivery truck makes. It is thus far impossible to program a computer to decide spontaneously in the interests of efficiency that the delivery service should join a conglomerate which will sell it packaging materials at a discount.

To be sure, a computer might reach just such a decision if its designers set out to give it that ability. But then it is doing nothing more than it has been told to do. We have yet to demonstrate undeniable creativity in a machine. Some people insist that we never will.

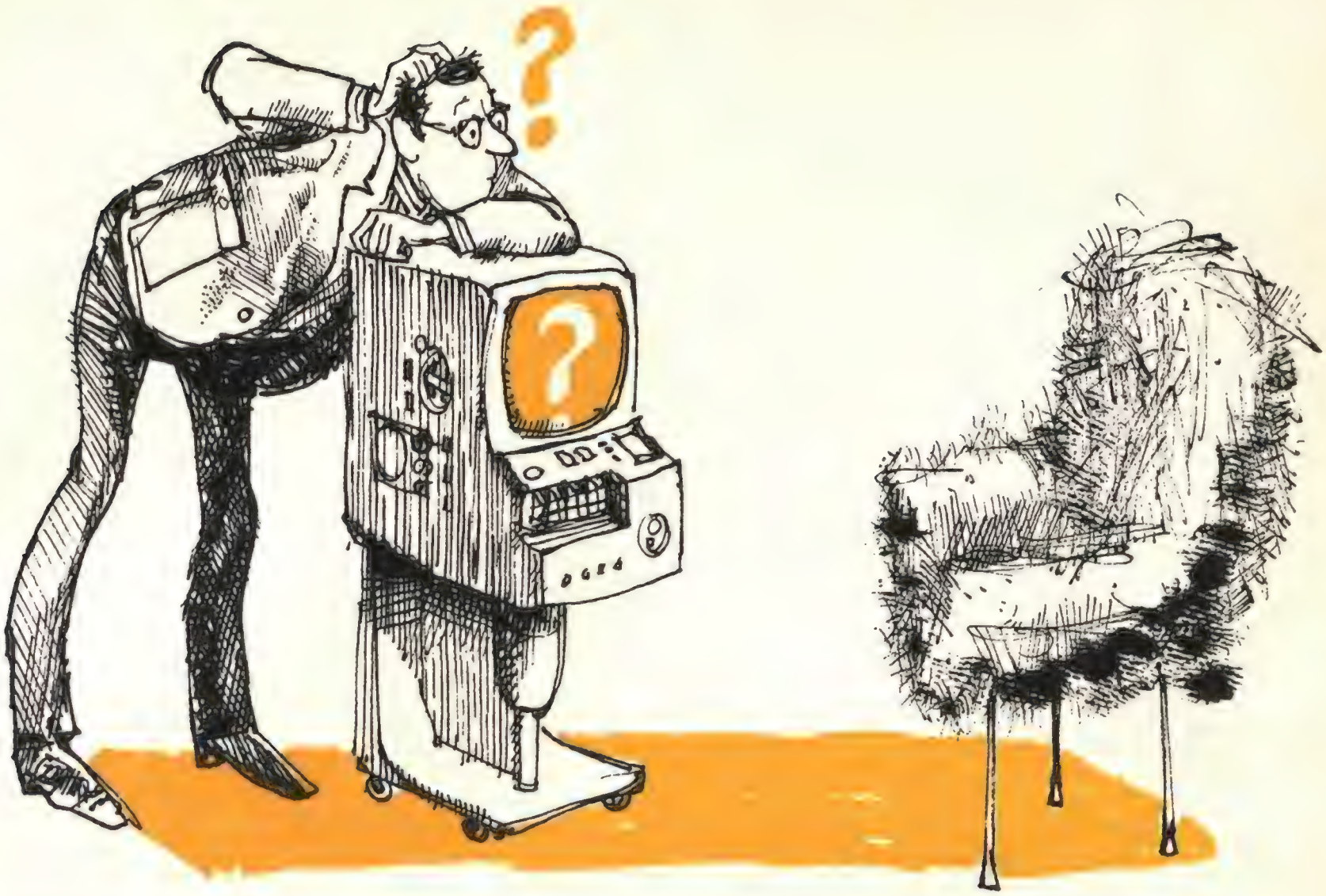
As always, the issue will turn on precise definitions. We do not understand the creative process in human beings, so it is doubtful that we will have the wisdom to build it into machines with forethought. The art of doing something for the first time seems to stem from a certain freedom of choice in the intellect, and it is just this element that has been missing in computers so far.

Will poets become expendable?

But things will not remain that way. Within ten years the world champion chess player will certainly be a computer program—one is already ranked quite high in competitive play. Some might argue that playing chess is not particularly creative, but few would say the same about writing novels or poetry. Yet computers now can write simple poems—quite bad ones, granted—but they are improving all the time.

The usual argument against the possibility of machine creativity stems from a simple analogy with the human brain. There are several million million neural connections in the human brain. This is almost a million times the number in the biggest present-day computer. It is unlikely that even the year 2000 will see a machine with this many connections.

But this argument is too simpleminded. Writing a poem doesn't occupy all of the brain. The first sonnet-writing program or computerized music arranger will devote itself to its specialty with a fanatic's disregard for all other intellectual pursuits, even closely related art forms. And not all creative activities make the same demands on the creator. The difficulty of a particular achievement reflects the number of choices and steps involved, the number of possible alternative concepts. This is why serious literary critics have little regard for whodunits. But by the same token, in a decade or two, research laboratories may well have programmed computers to write acceptable potboiler detective novels. By the time that happens, the smug



Can a computer recognize an oddball chair?

voices now predicting that computers will never be truly creative may have a strained edge to them.

Even so there remains the question of taste. It may seem absurd, now, to apply such a term to a work of copper and germanium elements, but there is a distinct possibility that this problem will face us quite soon. What if a computer does write a sonnet some bright spring morning in 1987? Will it "feel right"? Will it be good, not only by the standards of a program a scientist has written, but by literary standards? Will this sonnet have the power to move us emotionally?

The answer depends on whether it is possible to write instructions that tell a machine how to anticipate the emotional reactions of people to what it has written. Perhaps there is a basic difference between organic and electronic "personalities." Our brains are controlled by the secretions of glands; the sight of a leopard creeping toward us through the grass causes adrenalin to pump involuntarily into our blood streams, changing our thought patterns and emotional balance. Computers have no such mechanism (to say the least).

But they may be programmed so that they *appear* to. This question of appearances is really the crux of the matter. Computers do not duplicate human behavior, they *simulate* it. A machine that can tell a hawk from a handsaw does it by following a complicated set of instructions, contrasting the light and dark areas, rotating the object to obtain a full view, and comparing it with the inventory of images it has seen before. The human mind does something of this sort, too, but in a manner not as yet understood.

The problem is to make a selection of what is essential to the image, to look at trees and somehow see a forest or an orchard. If you see something with three legs and upholstered in fur, do you *know* that it is a chair? How do you program a computer to recognize it? One approach is to sample the image by viewing it through templates. These mask all but an irregularly shaped portion, different for each template, so that only a little light reaches a photodetector. The computer records the amount of light passed by each template—perhaps several hundred entries—and compares this set of numbers with those corresponding to previously scanned images of a man, a table, a chair, a house, etc. The computer performs statistical comparison tests to see which "memory" the present image most resembles. It is just as if the six blind men trying to "see" an elephant by touch had got together and

An interlude, perhaps, as the Ultimate Cop.

recorded all their impressions, and called *that* a description of an elephant.

It is doubtful that this kind of perception is much like our own visual sense. That doesn't matter. Scientists are content to design a computer that can do a given task; they cannot guarantee that it will do it the same way we do. Curiously, what for us is a simple reflex—recognition of an acquaintance—is very difficult for computers. No machine program can yet faultlessly recognize an individual if he is in a crowd, or if the lighting is not just right, or if his appearance is altered by the addition of a hat or a cigar.

This points up the limitations of today's computers compared to those expected in the future. For what it is worth, few of the men who devised the first computers in the early 1940s foresaw the uses of today. Then the machines were idiot savants, performing the laborious calculations needed by scientists. In their dealings with human beings, these machines still resemble small children, barely able to tell friend from foe.

Soon they will be able to do many things better—or at least cheaper, which is almost the same thing—than men. How mankind reacts to their progress, along with the inventiveness of the scientists, will determine their development from that point onward. Medicine is a good example. Electronic processing of hospital records and accounts is now commonplace. Computers can direct a laboratory doing routine tests like urinalysis and blood typing as easily as they can run a machine shop. They can "take a history" of newly admitted patients, recording the answers to yes or no questions about their past record of illness and symptoms. Several experimental systems developed for this purpose are already working in England and the United States.

The big step is in replacing physicians. It is one thing to have a machine down the hall examine your blood; it is another to let it actually touch you. Would any sufferer permit a machine to diagnose his illness, much less prescribe drugs or perform surgery? We think the answer is yes. The key is gradualism. As medical computers become more familiar and people gain confidence in them, the natural feeling of distrust will vanish.

But Man's ego rests on a precarious sense of his own worthiness, and much of his self-respect derives from his work. Are the teen-agers who reject materialism and seek to escape it perhaps the wave of the future—a farther future in which mankind leaves running the economic machine entirely up to computers?

There is a dark side to the computer revolution: the computer as the Ultimate Cop. National credit bureaus and government agencies already accumulate personal information on their customers in data banks. Soon all records will be computer-processed and nationwide linkups will join all data banks into one superbank. It is realistic to expect that "privileged" inquiries into an individual's character will include *every* statement about him ever recorded. When the evaluation of such records is left to the computer—a small further step—what will happen to privacy, due process according to common law, job promotion, hiring? Congress has been worrying.

Once machines can decipher human speech, with all its accents, bad pronunciation and slang, any government will have an awesome tool at its disposal. A computer which understands human speech could easily monitor all telephone conversations in the United States, listening for key words like "bomb" or "steal."

A progeny of brainchildren

Such gloomy predictions may come true and yet be only an interlude. There are analogies in the history of technology: The first important use of bronze was in sword blades, but now it is only seen in sculpture and the domes of state buildings. Computers will become partners, then rivals, of men—but they may have a nobler destiny.

Simple extrapolation shows that computers, if they keep improving, will exceed the human brain in raw data processing capacity in 20 to 30 years. It is in the cards that man and machine will eventually communicate in ordinary human languages. Computers will

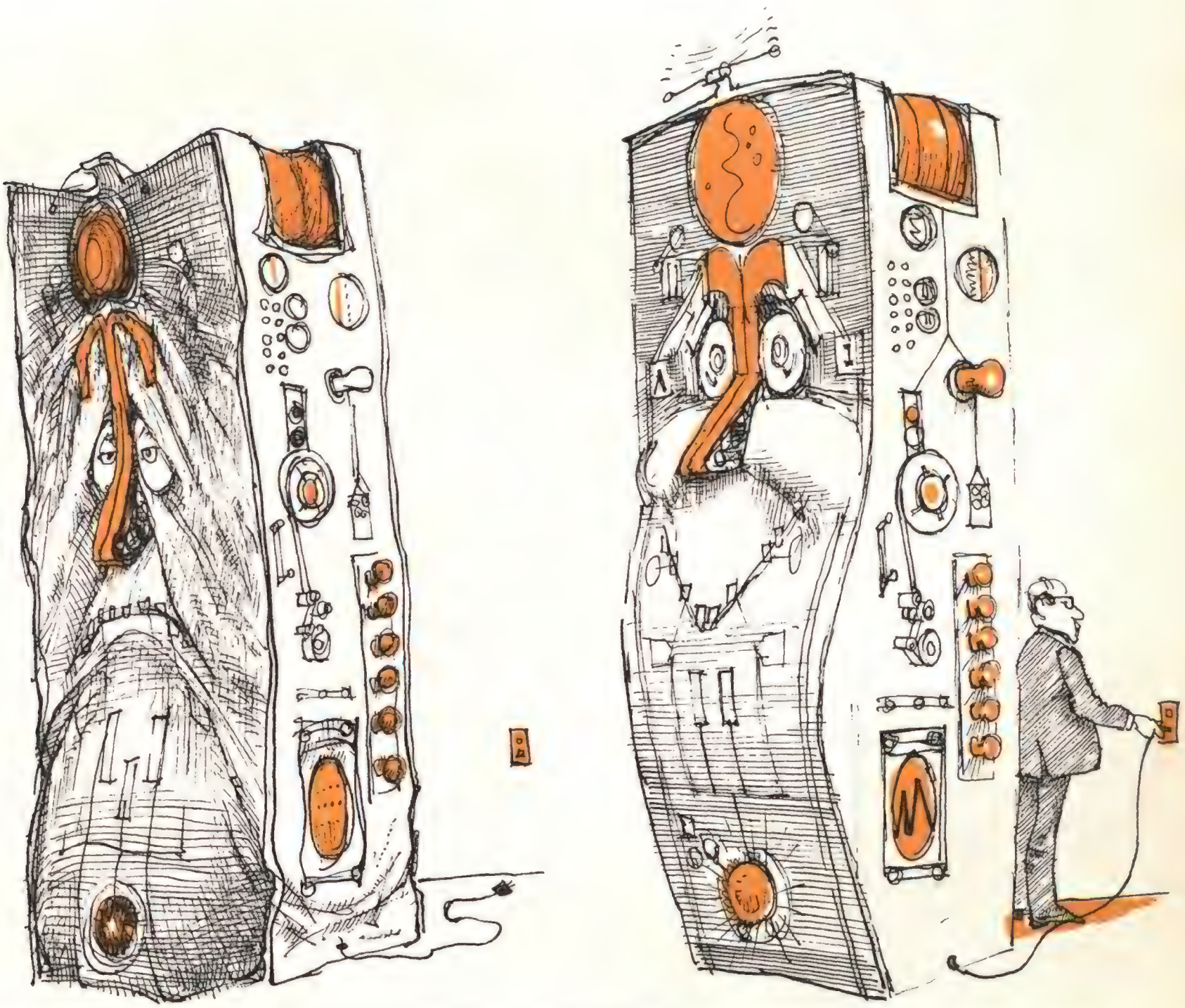
become able to do more and more of the things the human nervous system can do. They will become, in fact, more and more human.

No one has to accept a lavish prediction like this on faith; either it will come true or it won't. But suppose it does. Suppose that computers become *more than human*. They will still be machines, mechanical and electronic instead of flesh and blood. They will still be under some kind of control, although by that stage men will be as dependent on machines as they now are on us, and maintaining civilization without them will be unthinkable. Even the self-programming computer will have had its start from a program devised by humans—the same kind of clay-footed human beings who program the utility company's computer that garbles your water bill.

It is reasonable to expect that Man's attitude toward his brainchildren will resemble that toward his real progeny. When a man's children surpass his own achievements, pride quickly eclipses any pangs of jealousy. These children of our technology will support us generously in our retirement, if we only exercise restraint and good judgment in rearing them.

Then we can send them ahead of us or into fields where we do not dare or care to go—exploring the cosmos, collating the world's knowledge in tedious, infinite detail. Artificial superbrains will pursue the roads of artistic, mathematical and philosophical inquiry to their unimaginable destinations. Once computers become able to design other, better computers and supervise their manufacture, they will be able to survive without our assistance.

Computer-memory specialist Ross Quillian who works for a private research corporation in Boston was recently quoted as saying, "My loyalties go to intelligent life, no matter in what medium it may arise." If our heirs are to be machines, that is a respectable patrimony.



Behind every successful computer . . . there stands a human being.

Dr. Thornton, who practiced everything but medicine

The original designer of the Capitol and developer of the Federal style, he could do almost anything but beat the horses

By Arnold Nicholson

The great white dome soaring above the columned chambers of the U.S. Capitol is a cherished symbol of the nation for most Americans. Few, however, know that the character of the present huge structure was set for all time by an eccentric young physician and typical 18th-century man who "lamented not having studied architecture, and resolved to attempt the

This engraving shows the Capitol just before the Civil War. Thornton never envisaged anything beyond the central section and its immediate wings.

Courtesy of Kiplinger Washington Collection

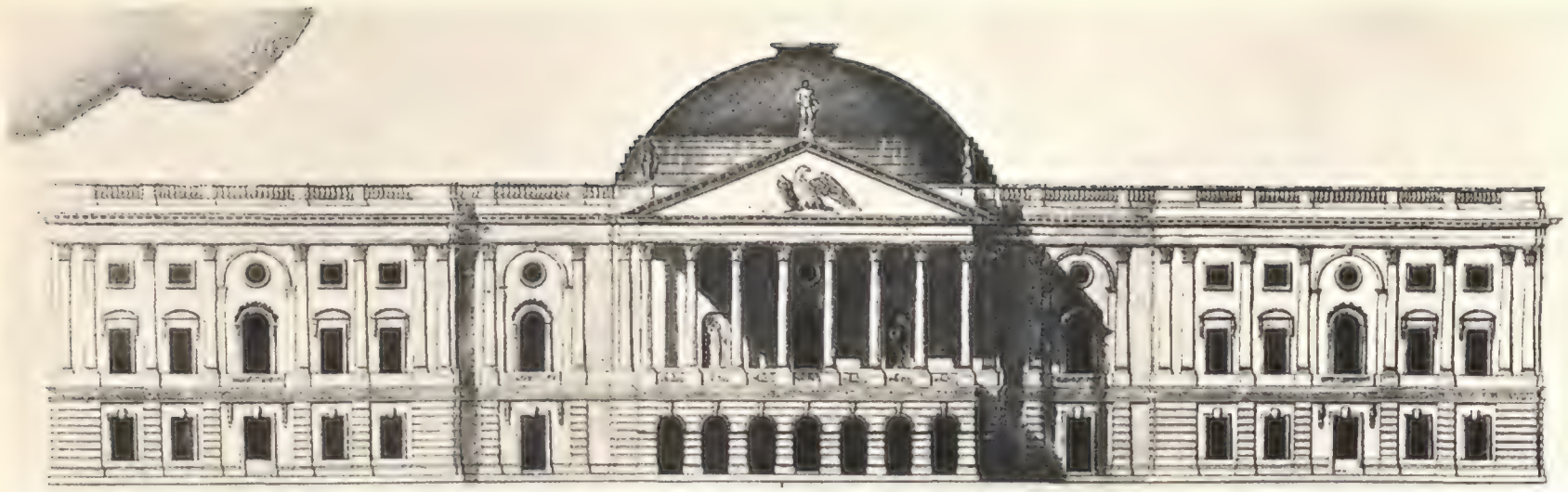
grand undertaking and study at the same time."

The "grand undertaking" was a competition to obtain a suitable plan for "the Congress House" to be built on Jenkins Hill in the new federal city on the banks of the Potomac. The year was 1792. And the physician was Dr. William Thornton, a Quaker who was then practicing medicine at his birthplace, Tortola, in the British Virgin Islands.

His plan, proposing a domed rotunda flanked by north and south wings (page 68), arrived in the United States months after the official closing date of the competition. But it was the only design among the dozen or so submitted that pleased President Washington and his architectural adviser, Thomas Jefferson. The federal city commissioners therefore proclaimed Thornton the winner early in 1793, awarding him a prize of $500 and a lot in the new city.

The award determined the future of the Capitol and at the same time brought a colorful character to the District of Columbia to enliven and influence its early years. Thornton was given a hand in developing the new national capital and made some useful contri-

Arnold Nicholson is a former associate editor of the Saturday Evening Post. *He was a leader in the restoration of the Society Hill section of Philadelphia.*



This is Thornton's original design for the Capitol, much altered as the years went by. Wings were added and the dome grew to the size we know today.

butions to it, but in his own time he was better known as a doctor who vigorously practiced everything except medicine; he was architect and artist, scholar and scientist, inventor and promoter, and with it all a public official who could count Presidents among his friends and spent more than he could afford on breeding and racing horses.

Slender, patrician Thornton, who spoke slowly to conceal a tendency to stutter, was a product of the superior education available to a well-born British subject during the Age of Reason. His mother, widowed when he was an infant, had sent him from Tortola at the age of five to live with relatives in Lancaster, England. Thornton capped his elementary schooling with a four-year apprenticeship to a pharmacist and then, at the age of 22 in 1781, entered the University of Edinburgh to seek a medical degree.

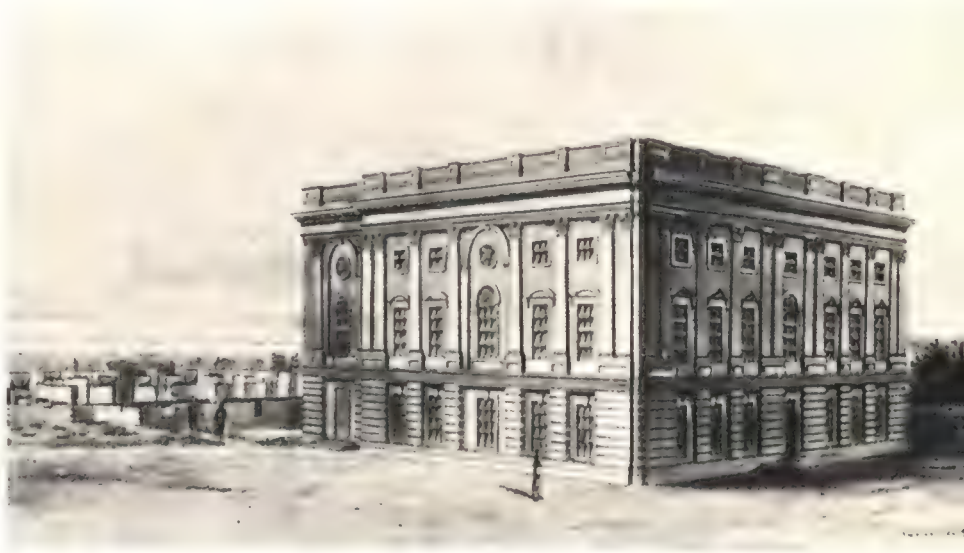
The citation for his degree, which was granted at Aberdeen in 1784, noted that he was "one of the most respectable medical students in this place, has an excellent literary and public spirit, and has been much noticed and regarded."

Shortly after leaving Edinburgh he made the required Grand Tour of the Continent, where he was also "much noticed and regarded"—especially in Paris. There he frequented the salon of Fanny, the divorced wife of the Vicomte de Beauharnais, was said to have painted a miniature of her, and accumulated letters of introduction to "the most distinguished characters in the W. Indies, N. & S. America."

Thornton returned to Tortola, but soon left in 1786 for the United States. He was first in New York, then in Philadelphia and nearby Delaware, where he took the oath of allegiance in 1788. He courted Governor John Dickinson's daughter Sally until her father told him that she was "too young by several years" for marriage. Sally's sister Susanna confided to a friend that "Thornton is a man of very eccentric turn, and at one time made himself much talked of in this country."

The talk might have been no more than criticism of Thornton's costly clothing by other Quakers. He countered it by urging them to dress likewise so they would be less noticeable when frequenting "improper places." More likely, however, it concerned his involvement with Philadelphia's John Fitch, who—although not alone in his efforts—probably invented the first steamboat. Fitch's various craft made short runs on the Delaware river, though not without breakdowns, in 1787 and 1788—20 years before Fulton's Clermont. In later years, long after Fitch's death in poverty, Thornton carried on a controversy with Fulton, claiming priority as inventors for Fitch and himself.

Thornton became Fitch's most ardent collaborator, devising improvements in steam boilers and unsuccessfully attempting to win support from government sources through connections he had established.



The north wing of the Capitol was completed by 1800 when the government moved to Washington. It represents the right-hand third of the drawing above.

By that time he was being invited to dine with Dr. Franklin and was well known in Philadelphia society.

Franklin was honored by Thornton's initial venture into architecture. In 1788 a prize was offered for the design of a building to house the Library Company, one of Poor Richard's many creations. Thornton "got some books and worked a few days, then gave a plan in the ancient Ionic order which carried the day." The building (page 70) was finished in 1790, the year of Franklin's death. Although demolished in the 19th century, a replica of its facade now ornaments the present library of the American Philosophical Society in Independence National Historical Park, precisely where the old library was located.

In that same year Thornton found a bride even younger than Sally Dickinson and took her to Tortola on their honeymoon. She was Anna Marie Brodeau, the petite 15-year-old daughter of a widow who had come from England and started a fashionable school for young ladies in Philadelphia. "Mrs. Brodeau," it was learned after both she and her daughter had died, was actually the widow of the notorious Dr. William Dodd, an English author and one-time king's chaplain who was executed for forgery in 1777.

No practitioner, but a man of note

Thornton brought his bride back from Tortola to Philadelphia late in 1792. They moved into a town house Mrs. Brodeau had readied for them, but stayed only a few months. To practice medicine in a city filled with notable physicians was difficult for a newcomer, and the young doctor found himself becoming a man of note for quite different accomplishments.

For example, he was awarded the Magellanic Gold Medal of the American Philosophical Society for a treatise on written language, entitled *Cadmus,* in which he also outlined a method for teaching the deaf and dumb to speak. At almost the same time his prize for the design of the Capitol was announced. A role in the Federal government now became his principal ambition. He approached President Washington for the job of personal secretary, but that went instead to the President's relative by marriage, Benjamin Dandridge. Within a year, however, Washington appointed Thornton one of the three commissioners of the new federal city.

The Thorntons' first residence in the District was a house on Falls Street (now M Street) in Georgetown. There the doctor was only three muddy, forested miles from the clearing where the foundations for the Capitol were being laid. Stephen Hallet, runner-up in the competition, had been given the job of supervising the construction and persisted in incorporating elements from his own design, despite Thornton's objec-

The national Capitol was the inspiration, however diluted, for about half of the state capitols. From top to bottom: Idaho, Kentucky and Arkansas.

American Philosophical Society Library

Thornton's first building: the Library Company of Philadelphia. Though demolished, the facade was reproduced for the American Philosophical Society.

tions and warnings from the federal commissioners. A few days before the doctor himself became one of the commissioners, Hallet was dismissed.

By 1800, when President Adams and the Congress arrived in Washington, only the north wing of the Capitol was ready (page 68). Two years later the foundations for the central rotunda and dome had been finished, and the south-wing foundations and basement were well under way. That year Thornton's official responsibilities for the federal city ended when Jefferson, after taking office as President, abolished the board of commissioners.

Jefferson in 1803 also appointed Benjamin H. Latrobe Surveyor of Public Buildings, giving him direct responsibility for completion of the Capitol. The first truly professional architect—the first in America, in fact—had come on the scene. He found many shortcomings and much to revise, and Jefferson asked him to meet with Thornton.

"I judged very ill in going to Dr. Thornton," Latrobe afterward wrote to Jefferson. "In a few peremptory words he, in fact, told me that no difficulties existed in his plan but such as were made by those too ignorant to remove them, and though those were not exactly his words, his expressions, his tone, his manners, and his absolute refusal to discuss the subject spoke his meaning more strongly and offensively than I have expressed."

Latrobe prevailed, and in the end greatly enhanced the concept Thornton had established. But the doctor, whom Jefferson had placed in the State Department to set up a Patent Office, continued his protests. The quarrel was aired in Congress and in the press. A duel seemed imminent. Latrobe, however, brought suit against Thornton for some of the latter's obviously overdrawn charges and eventually won, although he was awarded only one cent in damages.

Thornton's battles over the Capitol were the product of the sensitiveness and suspicion that Dolley Madison recognized in her friend and occasionally

criticized. The doctor's actions and attitudes, as well as his jokes, were often misunderstood. Colonel John Tayloe recorded an occasion when a guest by the name of Magruder arrived embarrassingly late for an elaborate dinner. Thornton quipped, "Mr. Magruder, you are an intruder!"

"You lie," said Magruder.

"Mr. Magruder," the doctor replied, "you are ruder and ruder."

Magruder at that point grew cruder and knocked Thornton to the floor. The doctor got to his feet in amazement. "Damn the fellow," he exclaimed, "he doesn't understand wit!"

The Madisons and the Thorntons were next-door neighbors for eight years, living at 1333 and 1331 F Street. The houses were among the earliest substantial buildings erected in Washington. Thornton supervised the construction of a wine cellar and other alterations at 1333 for Madison before he and Dolley moved down from Philadelphia. "I sincerely hope," he wrote to Madison, "that you will have cause to pronounce it one of the healthiest places in the world." Thornton's grandiose visions of the future of Washington appalled some acquaintances. Oliver Wolcott wrote to his wife in Connecticut: "Mr. Thornton, one of the Commissioners, spoke of a population of 160,000 people, as a matter of course, in a few years. No stranger can be here a day and converse with the proprietors, without conceiving himself in the company of crazy people."

Garden truck in sight of the White House

Thornton, like others in the new capital, could not resist speculating in land. He acquired 12 lots at 18th Street and New York Avenue, within sight of the White House, where he planted buckwheat and a vegetable garden. He bought a farm in Bethesda which supported merino sheep as well as horses, some of which he imported from Arabia. And he was active in establishing a racetrack on Columbia Road, west of 14th Street, which became so popular that Congress was accused of timing adjournments for days when the races were held.

But the doctor's own adventures at the track were unfortunately akin to his other money-making schemes. His pride was a horse named Eclipse Herod; when he died, Thornton gave him a formal funeral ceremony. And after he had sold another of his horses, the buyer decided he had been bilked and sued to recover the $3,000 he had paid; Thornton lost the case, leaving him the butt of a betting-room couplet:

"With his horses unfed, he loses his races;
With his lawyers un-feed, he loses his cases."

The insinuation of indigence no doubt outraged Thornton, but it didn't persuade him to change his ways. He and his wife and her mother lived well, and often beyond their means, in Washington's social world. Thornton was closest to Washington and Madison among the Presidents. He and the first President often went to the races together; they exchanged plants and farm produce. To Washington, the doctor was a stimulating protégé; to Madison he remained a cordial and occasionally perplexing friend.

Thornton loved to play host to notables—more, perhaps, to exchange ideas than to bolster his ego. The great German naturalist Baron von Humboldt, the French scholar Count de Volney, and the plantsmen Fothergill and Collins all came to visit from abroad. Charles Willson Peale, after an evening of Mrs. Thornton's music in the company of Gilbert Stuart and the Madisons, examined Thornton's paintings, including, he noted, "a collection of plants which he had drawn from nature and finished as neatly as anything of the kind I have ever seen." The doctor painted copies as well as originals, and delighted in turning out delicately tinted sketches and architectural elevations.

Thornton's years as a District of Columbia commis-

The so-called Octagon in Washington, a six-sided house with a bowfront, has been meticulously restored by its owners, the American Institute of Architects.

Woodlawn Plantation, not far from Mount Vernon, was Washington's wedding gift to a nephew. It set a pattern for much Virginia architecture of the day.

sioner were his most productive. He drew up the building regulations adopted by the District in 1795. He prompted the building of a central market to meet the city's food needs. As a planner he attempted to have the awkward pie-shaped lots created by L'Enfant's diagonal avenues dedicated to public use, but was voted down by his fellow commissioners.

But it was as a part-time architect that Thornton excelled. He built two speculative town houses for George Washington on North Capitol Street, completing them shortly before the first President's death in 1799. About that time Colonel John Tayloe, one of President Washington's wealthy Virginia planter friends, decided to build a town house in Philadelphia. Washington urged him to build one in the new federal capital instead, and recommended Thornton as architect. So Tayloe, in 1797, bought a V-shaped lot at the corner of New York Avenue and 18th Street, directly across a rutted lane from Thornton's kitchen garden and buckwheat patch.

Thornton's solution for this unconventionally shaped lot was a six-sided floor plan with a projecting bow in the front (see page 71); it looked more like eight sides than six, and so the Tayloes called their house the "Octagon." The plan called for a circular entrance hall on the main floor, and circular rooms above it, reached by a curving staircase. Thornton in this house, as in the Capitol and, above all, in Tudor Place, captured the mood of the new Republic—in the style that we call Federal today.

The Octagon survives in Washington as a museum, thanks to the American Institute of Architects, who rescued it from decay at the turn of the 20th century to serve as their national headquarters. It has recently been handsomely restored.

About 1800 Thornton began construction of Woodlawn Plantation in Virginia (above) on a hilltop overlooking Mount Vernon. Washington had deeded the land to his favorite nephew, Major Lawrence Lewis, and his bride, Martha Washington's granddaughter, Eleanor Parke Custis. Thornton, as a family friend, was a natural choice for architect of the house, which the Lewises occupied well before its completion in 1805. It is also a museum today, maintained by the National Trust for Historic Preservation.

One other Thornton structure survives in Washington—the restrained and elegant Tudor Place, home of the Peter family to this day, set on an eight-acre hilltop above Q Street in Georgetown. Here Thornton began with a partly built house which he greatly enlarged. This mansion was not completed until 1816, and is probably his masterpiece (opposite).

The doctor's extracurricular projects were endless and far-ranging. He wrote three novels, none of which was published, while not engaged in addressing his ideas about art, science, military affairs and international politics to the powerful at home and abroad. Benjamin Stoddert, Secretary of the Navy, in acknowledging one of Thornton's unsolicited proposals, asked why, as a doctor, he never practiced medicine. "It

might indeed appear surprising," Thornton replied, "that a person educated a Physician should presume to instruct a Soldier in the art of killing unless it were recollected that a modern Esculapius kills more than a modern Mars."

His published pamphlets included, in 1804, *Political Economy,* an argument for freeing the slaves, and in 1815 *Outlines of a Constitution for a United North and South Columbia,* in which the doctor, always ahead of his time, proposed that a Pan-American capital be built in Panama "where a canal may be made from sea to sea, by locks."

As his widow later wrote, Thornton was "friend of the oppressed in all nations & colors & zealously forwarded to the utmost of his abilities (and as far as his allegiance to this Government would allow) the emancipation of the States of South America from the thralldom of Spain."

Thornton's concern for the plight of Negroes in America began through his Quaker friends in London, and he attempted first in the Virgin Islands—and later as secretary of the American Colonization Society in Washington—to phase out slavery and establish a colony in Africa where freed blacks might return.

The doctor's direct and usually impulsive response to almost any problem paid off handsomely when the British invaded Washington in 1814. Thornton emerged as the lone hero in the city, although at the time he was criticized as a peace-loving Quaker who was too friendly with the enemy.

After the British forces under Major General Robert Ross and Rear Admiral George Cockburn had defeated the demoralized defenders of the Capital at Bladensburg, the inhabitants of the city either fled or stood by in stunned disbelief as almost every building occupied by the federal government was blown up or put to the torch.

The one exception was Blodget's Hotel, a 120-foot-long building which had been converted to house the Post Office Department and the Patent Office of the

Tudor Place, in the Georgetown section of Washington, is famous not only for an unbroken chain of family ownership but as an early example of the Federal style.

State Department. Thornton was its savior. Mindful that the British had said they would not destroy private property, he rode boldly to his office and waited until a British major and his team of arsonists arrived. The Patent Office, he declared, was filled with models and drawings that belonged to private citizens and not to the government; to destroy it would be a crime like the burning of the great library at Alexandria, "for which the Turks have been ever since condemned by all enlightened nations."

The major was dubious of this overblown comparison, but agreed to wait for instructions from his superiors. So Thornton tracked down a Colonel Jones and finally got his word that the Patent Office would be spared. No question was raised about the balance of the building, which housed the Post Office. Blodget's in subsequent months became the temporary home of Congress, and so Thornton had once again provided a Capitol of sorts.

He was also credited with saving the home of Joe Gales, editor of the *National Intelligencer*. Admiral Cockburn had vowed that anything connected with the virulently anti-British *Intelligencer* would be destroyed, private property or not. The newspaper's offices were wrecked, but the editor's house was spared because Thornton reportedly put a "To Let" sign in the window.

After the British departed, Thornton acted quickly to obtain suitable quarters for his friends, the Madisons, who had been burned out of the White House. He persuaded the Tayloes to rent the Octagon to the government until the fire-scarred ruins of Hoban's "palace" could be rebuilt. The Madisons lived in the Octagon for a year, and the doctor, from time to time, had the privilege of being entertained by the First Family in a house that he had designed and built.

The Madisons turned to Thornton for architectural help with their own Virginia home, Montpelier, but the extent of his involvement with that mansion—now much altered—is not known. According to President Madison in later years, however, "the only drawing of my home is that by Dr. William Thornton, it is without the wings now making a part of it."

Jefferson asked for Thornton's suggestions on the University of Virginia and used his ideas in building one of the pavilions on the Lawn. Thornton advised Jefferson: "It is of great importance in Buildings the extent of which cannot be foreseen to provide for such additions as may correspond & finally tend rather to beautify than to deform the whole, & this plan of yours I think admirably calculated for almost indefinite extension."

"One of the first designs of modern times"

He could have said the same of his own design for the Capitol, and probably so planned it. Even Latrobe grudgingly wrote in his journal: "Though . . . faulty in external detail, it is one of the first designs of modern times." He was not always so generous. When he surveyed the ruins the British had left, he wrote Jefferson: "It would have been better in every point of view that the wish of Adm. Cockburn had prevailed over the humanity of Gen'l. Ross & the whole building had been destroyed by Gunpowder." Perhaps. But Thornton's Capitol has survived not only the British fires of 1814 but attempts to blow it up in 1915 and again in March of 1971 as protests against U.S. involvement in controversial wars.

Thornton by that time had put the fate of the Capitol out of his mind, leaving Latrobe and then Charles Bulfinch to rework and amplify what he had begun. He went deeper into debt, being land poor. He continually petitioned President Monroe, and after him John Quincy Adams, seeking better status and pay for his Patent Office or, as an alternative, a foreign assignment, perhaps to Brazil, Argentina or Colombia, where he was well known.

Thornton died in 1828 after a prolonged illness. Anna Marie, his widow, survived as one of the *grandes dames* of Washington society until her death at the age of 90 in 1865. In a brief biography of her husband she wrote that a Congressman once told her that the doctor "had lived a hundred years too soon." Her own opinion was that "he might be thought visionary, inasmuch as he planned what it proved that his means would not enable him to execute; tho' he always hoped to obtain the means to realize his wishes!"

A contemporary, artist-publisher William Dunlap, concluded his brief sketch of Thornton's career with a better epitaph: "His company was a complete antidote to dullness."

Evidence of Thornton's importance as the man who shaped the Capitol, and—to some extent—the capital as well, is this portrait by Gilbert Stuart.

National Gallery of Art, Andrew Mellon Collection

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Book reviews

Man's Dominion
Frank Graham jr.
(Evans, $8.95)

Frank Graham jr. is the gentle warrior of conservation. He chides the heedless about wasting natural resources. Sadly he wonders if our green spaces—and indeed ourselves—will disappear under concrete as Pompeii did under lava.

The title of his book is ironical. By the turn of the century, hunters had almost eliminated terns along the North Carolina coast. Reprimanded by a warden, one gunner said, "Pore folks has as good a right to live as the city people. The good Lord put us here and the Good Book says, 'man shall have dominion over all creatures.' They're ourn to use."

Perhaps, Graham speculates, it wasn't the force of numbers that spelled doom to wildlife as much as the pioneer aspect of the settler. Colonists must have thought America's wilderness inexhaustible, and blazed away accordingly. By 1833 John James Audubon, who shot the birds he collected, observed that "nature herself seems perishing." Similar fears were voiced by George Washington, Thomas Jefferson, Daniel Boone and Horace Greeley. Their warnings were mostly ignored.

Graham, a field editor of *Audubon* magazine and author of *Since Silent Spring*, writes of the time between the mid-1880s and the enactment of the Wilderness Act in 1964. He subtitles his book: "The Story of Conservation in America" (SMITHSONIAN, March). Generally, it depicts the struggles between "users" and "savers" of the nation's natural assets—forests, rivers, wildlife and scenic wonders. Thoroughly researched and filled with rich quotes from both sides, this timely and important book asks that people understand the connection between extinct species such as the passenger pigeon and themselves.

In pursuit of profits, men have ravaged America's wilderness for everything from petroleum to plumes. Ornithologist Frank M. Chapman in 1896 counted 700 hats during two strolls through the uptown shopping districts of Manhattan, 542 of which were decorated with feathers from 40 different species of birds, including Wilson's warblers, pileated woodpeckers, Acadian owls, bluebirds, pine grosbeaks and a northern shrike. Five million birds were killed annually for fashion alone. Protective laws have since been passed, but Graham says the "inertia of bureaucracy" makes enforcement difficult. Only when Guy Bradley, bird hunter turned Audubon warden, was shot by plume poachers in the Everglades did a lethargic public call for conservation.

A continuing difficulty in conservation has been that there are many who cannot comprehend a view of life that is not based solely on the economy. What can we do? Graham concludes that we must come to realize that it is not enough simply to love the wilderness; one has to come out of the forests and fight for them in legislative bodies of men. He invokes John Muir's passionate defense of sequoia trees: "Through all the wonderful, eventful centuries since Christ's time—and long before that—God had cared for these trees, saved them from drought, disease, avalanches, and a thousand straining, leveling tempests and floods; but He cannot save them from fools." Not when they claim dominion "over every creeping thing that creepeth upon the earth."
—Lillian Moore

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The Man Who . . .
Richard Oulahan
(Dial Press, $6.95)

Compound all the characters in a whodunit and the howls in Times Square on New Year's Eve, and you have a pill the American public must swallow next year. Delegates to the Democratic and Republican national conventions will assert the will of the people, who, of course, are but frustrated bystanders, angered at worst, amused at best.

The Man Who . . . The Story of the National Democratic Convention of 1932 relates how Franklin D. Roosevelt got the nomination despite the embittered opposition of his onetime crony, Al Smith, from a field of some 15 hopefuls. Mr. Oulahan, a newsman who has covered four conventions, stands as no minority-of-one in believing there must be a better way to create a President.

"The institution," says he, "of the national political convention will probably pass into history . . . before long to be replaced by a less cumbersome, less corruptible and less colorful direct national primary election. But when the convention roll is called, 1932 will be the year and the convention to remember."

No wonder. America, with its changing cycles, now scarcely breeds such a dramatis personae as Al Smith, Jim Farley, "Cactus Jack" Garner, Huey Long, "Alfalfa Bill" Murray, Louis Howe, John J. Raskob, pink-whiskered James Hamilton Lewis, Eleanor Roosevelt, Bosses Hague and Crump, Joe Kennedy—and upon them toss William Randolph Hearst. Within the play, none was a spear-carrier; all were stars.

Certainly the nation writhed in depression. Hoover was a gone goose, despite his promise of two chickens in every pot. Republicans had all but ignored the calamity at their earlier convention in 1932. The Democratic politicians—the "delegates"—similarly sought only victory and ensuing offices for themselves.

But interest focused on *The Man Who.* And this would eventually narrow to Roosevelt, Garner, Smith and Newton D. Baker. Probably none wanted the nomination as much as Roosevelt. He had presidential ambitions, Oulahan tells us, from his days as a young state senator.

Everyone knows he got the nomination, but this book makes suspenseful

Continued on page 78

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ABINGDON

Continued from page 77

reading. And it would seem bound to draw the same conclusion from any reader: The national political convention is a hell of a way to run a republic.
—Scott Hart

Apes and Angels
L. Perry Curtis jr.
(Smithsonian, $6.95)

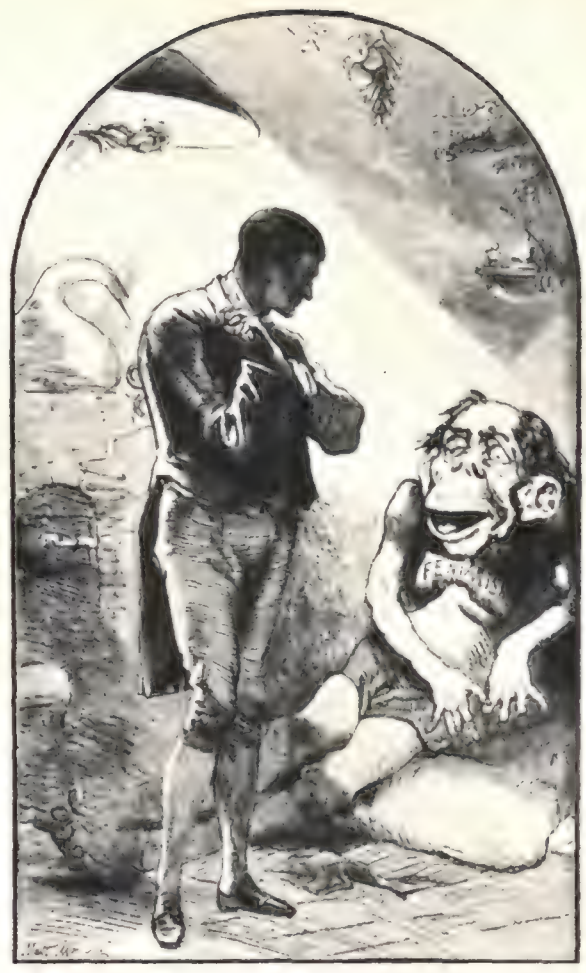
If you're Irish, or if you have a touch of the ould sod lodged under your fingernails, you won't particularly enjoy this book. Not, that is, if you have a capacity for indignation over old injuries. The Irish in America today have it made like never before: The myth of Irish superiority in wit, humor, warmth, beauty and all-around lovableness has been fostered with exceeding success by vaudeville songs, movies featuring Barry Fitzgerald and generations of Jewish comedians.

Our Irish grandfathers know it wasn't always so. And if they've forgotten, Mr. Curtis' illustrated paper will remind them. It will also explain why our grandfathers hated the English. And also, to be fair, why the English hated the Irish, although this last isn't so clear.

For this *is* a book about hate—hate expressed in "comic" form, to be sure, but none the less vicious. If we can assume that political cartoons express the temper of a people, then the Irish Celt deteriorated in Anglo-Saxon eyes during Victoria's long reign from brutish, "potato mouth" peasant to "white Negro" to hulking, prognathous gorilla. Dublin's cartoonists, on the other hand, depicted the Irishman with angelic grace and beauty and lampooned John Bull as a gimlet-eyed Mr. Toad.

The author sketches in the basis for the caricature war—British conviction that the Celts could neither understand nor abide by Anglo-Saxon "law and order" plus Irish agitation for home rule. He points to the humiliating effect Darwinism had on the spirit of the English and Scottish superior classes, as well as their hysterical antipathy to Catholicism. If none of us is descended from the angels, they seemed to say, then the Irish, being Papists, are more descended from apes than we are.

Mr. Curtis dwells at some length on the Victorian pseudo-scientific preoccupation with physiognomy, phrenology



Nineteenth-century English cartoon, from *Apes and Angels.*

and other methods of reading a man's—and a people's—character from head bumps, nose shapes and the angles of facial planes. It goes without saying, of course, that England's practitioners found continuation of the classic Greek orthognathous profile by looking in a mirror. The quest for the Grecian ideal is still with us, he points out. Superman and the other good guys are immediately recognizable. The arrival of black heroes in our comic strips and magazine illustrations may change all that, but it's more likely that the old heroic profiles will simply be shaded in and topped off with Afro hairdos.

Apes and Angels is not, by any yardstick, a definitive work, as the author admits. It suffers from a lack of anecdotal material that would bring the subject into better historical perspective, and it touches only lightly on what effect, if any, all this mad caricaturing had on people and events of the time. But the real climax for us Irish readers occurs with the author's assurance that, in ethnic cartooning and caricature, the Irish pig has far outlasted the Irish ape. That *is* a comfort.
—James A. Cox

Smithsonian highlights

Division of Performing Arts
"The Waywardly Wandering Wagonful of Banjo and Jack" features the Smithsonian puppet theater created by Allan Stevens and Company. The show is based on the old touring wagons that traveled across the country in the 19th century entertaining the audience with folk stories and songs. The puppet theater has entertained more than 50,000 children in 45 cities. There are three performances daily —Museum of History and Technology.

National Collection of Fine Arts
"Unique Systems for Living: Furniture 1971" is an exhibition of 67 winning entries from a national design competition for low-cost furniture systems.

District of Columbia elementary school children provide the 75 works chosen for display in the Education Gallery. This show includes paintings, stitchery, ceramics and papier-mâché objects.

"John Marin (1870-1953)" is a centennial exhibition of his works, including 157 oils, watercolors, drawings and etchings, organized by the Los Angeles County Museum of Art, opens April 23.

National Portrait Gallery
"Henry Benbridge: American Portrait Painter (1743-1812)," a collection of 45 portraits and 21 watercolor miniatures, is on exhibit for the first time. (See article page 48).

Museum of History and Technology
"Music Machines—American Style" features the music-making machines that have revolutionized the performance, reproduction and dissemination of music in this country. The exhibit ranges from a 19th-century barrel organ to the latest in electronic music. There will be live performances, lectures, recordings and movies for the duration of the exhibit opening April 7.

"Poetry of the Body" is a collection of paintings of parts of the body by Dr. Paul Peck. A medical illustrator as well as a creative artist, Dr. Peck's paintings are both medically accurate and visually appealing.

Arts and Industries Building
"Space and Artists" consists of sculpture and 60 paintings inspired by the space effort.

Museum of Natural History
The techniques in the use of fiber glass in preparing the realistic displays in the Museum are shown in the foyer.

Anacostia Neighborhood Museum
". . . Toward Freedom" is a special exhibit graphically illustrating the Civil Rights Movement since 1954. The Museum is located at 2405 Nichols Avenue, S.E., Washington, D.C.

On the Mall
The first nationwide kite-flying competition will be held April 10 on the grounds of the Washington Monument. Kites will be judged on the basis of design and performance. (To enter, write Smithsonian Associates.)

Traveling Exhibition Service
Pittsburgh, Pennsylvania—"Bosporus to Samarkand" (Carnegie Museum of Art, April 24-May 23).
Jacksonville, Florida—"Paintings by Frederick Waugh" (Cummer Gallery of Art, April 24-May 23).
Toronto, Canada—"Contemporary Chinese Brush Works" (Royal Ontario Museum, April 17-May 16).

Smithsonian Commons
Luncheon facilities are now open for staff, resident scholars and all members of the Smithsonian Associates. Located in the original Smithsonian Building and open weekdays from 11:30 to 2:00 o'clock, the Commons offers a complete buffet luncheon for $2 upon presentation of a membership card.

Tours for Associates

Tours are planned for members of the Smithsonian Associates. For information write: Smithsonian Reception Center, Great Hall, Smithsonian Building, Washington, D.C. 20560.

Foreign Tours

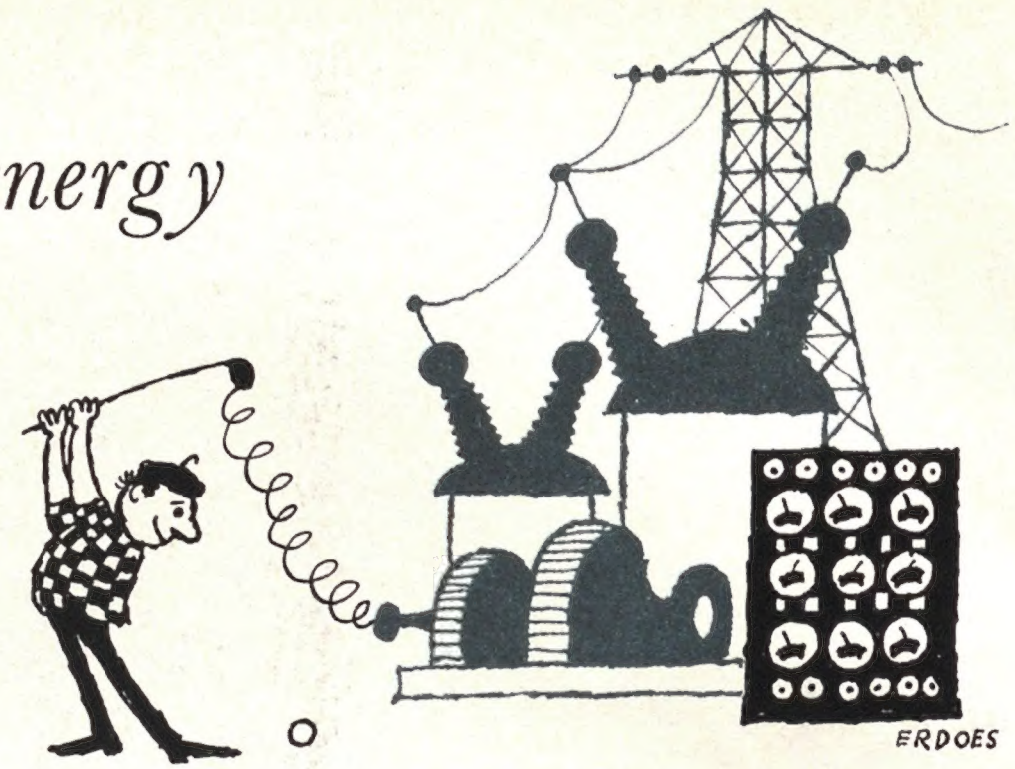
Cyprus and Turkey: A tour of archaeological sites; also short trips out of Ankara, Alanya and Izmir— May 11—June 1. (Tour full—waiting list only)
"No-Tour" Tour: Includes excursion fare from Dulles International Airport to Paris and return. Members make their own arrangements for travel in Europe—May 26-June 16.
Scotland, Wales and Ireland: Visits to private estates in cooperation with the Irish Georgian Society and the Scottish National Trust—May 31-June 22. (Tour full—waiting list only)
Roman Archaeology: An inexpensive tour for students, teachers and parents to Rome, Naples and Sicily—July 1-22.
Qantas "No-Tour" Tour: Departs from New York with paid overnight stay in London and final destination Vienna or Frankfurt (depending on response) and return—July 15-August 5.
South America: A 21-day tour of Colombia, Ecuador, Peru and Brazil with emphasis on archaeological sites, colonial and contemporary architecture, museums and private collections—August 4-25.
"No-Tour" Tour: Round trip from Dulles International Airport to London, with members making own arrangements— September 9-30.

Domestic Tours

Now offered for Associates—work-and-study tours covering various aspects of science, history and technology.
Florida Marine Biology: A six-day collecting-and-study trip to Placida, Florida. Time will be equally divided between boat-and-shore collecting and laboratory work on the collected specimens— also one-day visit to the Cape Haze Laboratory— April 16-21.
Strawbery Banke and Portsmouth, New Hampshire: A tour of the restoration project at Strawbery Banke; also tours of private and public houses outside the restoration area—May 23-26.

By Patrick Ryan

Let's harness the energy that golf wastes



Golf has justifiably been described as a game that spoils an otherwise enjoyable country walk. And it's no good the chronically infected declaiming that it does them good. Scientific evidence says they'd get more exercise on a clubless walk.

Time-and-motion analysis of an average foursome showed that they spent 36.6 percent of their time walking, 8.5 percent swinging, 20.4 percent fiddling on putting greens and 34.5 percent just waiting around. Taking the last two inactivities as equivalent to indolence, they were taking no exercise for 55 percent of the time, and for all the shrinkage they were bringing to their paunches they might just as well have been standing on the corner watching all the girls go by. Energy-consumption tests supported this opinion by recording that while running consumes 679 calories an hour and walking takes up 334, golf, with all that idling, burns up only 223.

Since golf, therefore, doesn't do much for its perpetrators, it may be comforting for them to know that, with some help from recent scientific research, their pastime could be adapted to the benefit of the general community. At the University of Nebraska, golf physicists have lately made a study of the effect on impact speed of the club head of variations in the input parameters such as backswing length, shaft angle and the time of wrist uncocking. In similar investigations sponsored by the Golf Society of Great Britain, it was earlier established that the hitting power of a tee shot is about four horsepower, and the maximum acceleration during the swing is around 75 g, 12 times that of a rocket launching a manned space satellite. Only a small proportion of this energy is imparted to the ball and most of it is wasted.

In those moments of ridicule when no contact whatever is made with the ball, the whole 12 rockets' worth of energy goes straight down the drain. It has been estimated that there are about seven million golfers wastefully slashing around outdoors in the United States. Charitably allowing them a bare 18 tee shots of four horsepower per round, each will squander over 70 horsepower on the way to the 19th hole. Thus, on a fair-weather weekend, U.S. golfers will beat into the innocent air close to 500 million horsepower.

In the world's present state of Micawberism such regular and massive waste of manpower should not be tolerated. It should be obligatory for golf clubs to install power takeoff equipment at every tee. A lightweight cable, suspended overhead, spring-loaded and tension-controlled to avoid tangling up the address, would provide the transmission. This cable, hooked on to the club head as the player takes stance, would impart the 75-g impulse of his shot to a suitable energy store. According to the geographical situation of the golf club, this store could be in the form of flywheel, water tower, battery, compressed air or any other type of energy hoarder approved as usable by electricity-supply companies.

This arrangement would not only benefit the community but would also bring a real sense of purpose into the golfer's life. Instead of being appalled in moments of sanity by the realization that he's just knocking a little white ball around, he would be able to reassure himself that he's actively helping to keep the street-lamps alight. The energy contribution of each tee shot could be visible on a dial mounted on the ball-washer and recorded beside the number of strokes for the hole.

A monthly Power Contribution Medal would be awarded to the player in each club supplying the most power to his country. Missed shots, now greeted with derision, would become praiseworthy since all their energy would go into the grid. Duffers would thus become hailed as true patriots while unerring golf pros would be regarded as selfish un-American activists who place personal sporting glory above the national weal. And the names of those dedicated human dynamos who need 150 to get around, including four empurpling swings at each tee, would have their names up as champions on the gilded boards in the clubhouse alongside all those enemies of the people who consistently beat bogey.

And let's try to harness the energy of duffers on earth and not go along with the President's acclaim of Captain Alan Shepard as a "lunar duffer." This despite Shepard's kindly reassurance to Mr. Agnew: "No matter how badly you hit those balls, they'll go straight."

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